THE ENGINEER

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THE ENGINEER

Established 1856

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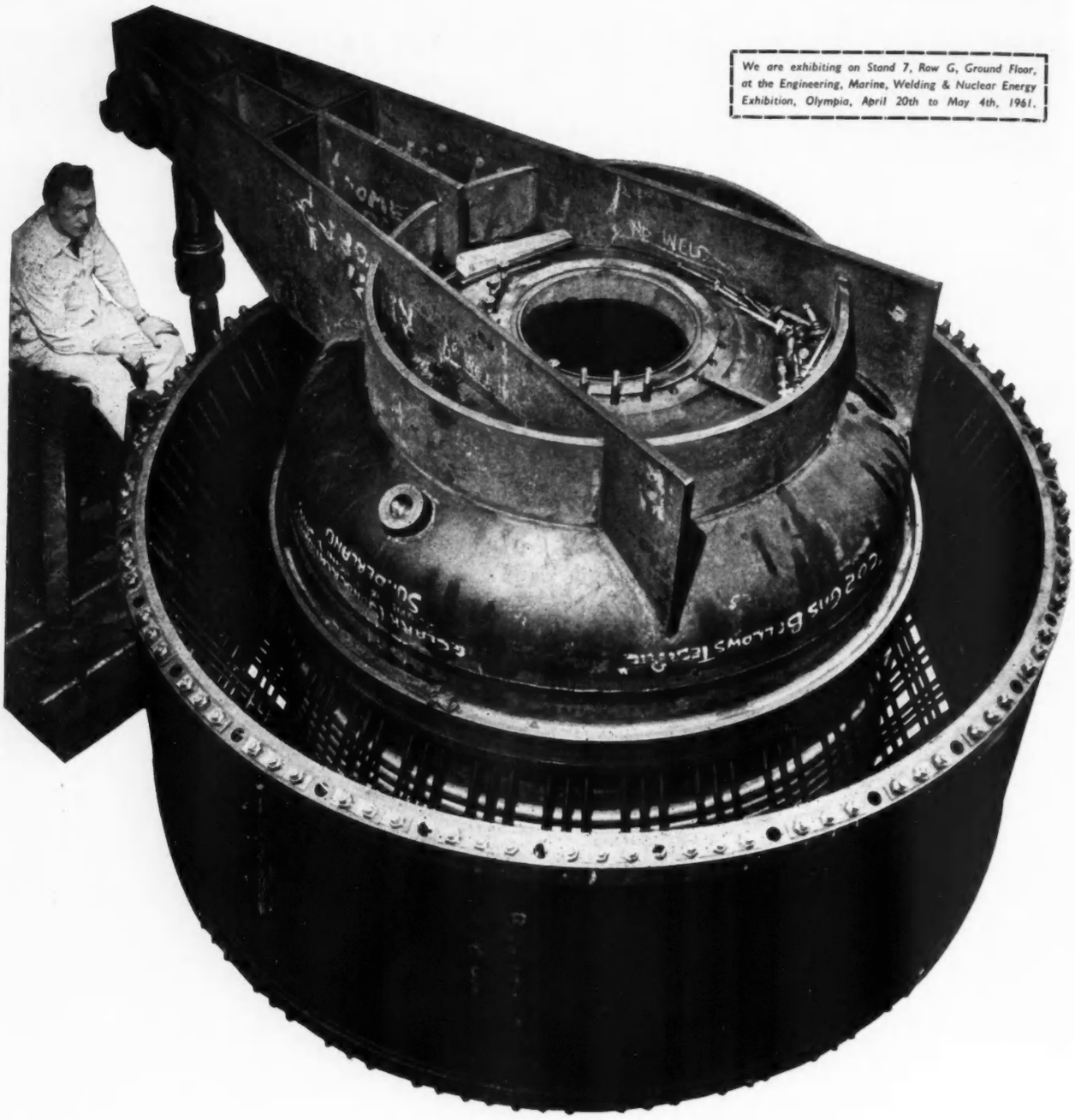
We are exhibiting on Stand 7, Row G, Ground Floor, at the Engineering, Marine, Welding & Nuclear Energy Exhibition, Olympia, April 20th to May 4th, 1961.



WELL, WHAT IS IT?

(To be fair we should point out that the domed top and fabricated cantilever are part of a test rig. The thing in question begins at the weld below the lettering).

Unless you happened to see, in an earlier advertisement, the cardboard model in which the idea took shape, memory will be no help. This is something quite new.

It is an expansion joint, one of 72 such joints that will take up the expansion of the CO_2 ducting at the Trawsfynydd Atomic Power Station. Internal pressure 265 p.s.i., temperature 420°C. The convoluted bellows holds the internal pressure; the end thrust—over 1,000,000 lb.—is taken by the inclined, high-tensile steel bars round the periphery; flexing is entirely by elastic straining of these bars. The illustration shows the joint being prepared for the Insuring Authority's acceptance test—1,250 full deflections under full internal pressure and temperature. Compared with previous joints for this kind of work it is lighter, simpler, cheaper. It is the kind of highly original solution to both new and old problems that Richardsons Westgarth engineers can, and frequently do, produce.

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THE ENGINEER

No. 5490 APRIL 14, 1961 Vol. 211

MAN IN ORBIT

As we go to press we learn that the Russians have scored yet another remarkable "first" in space. Last Wednesday morning Mr. Tovarich Gagarin was launched in a sealed capsule by rocket into an orbit that took him around the world in 108 minutes. The capsule was brought safely back to the earth's surface. We look forward to learning more within the next few days about the capsule and its launching rocket.

Congratulations to the Russians !

ECONOMIC SURVEY

Now that the "Economic Survey," instead of appearing in January, as at one time it did, is published only a week or two before the Chancellor of the Exchequer opens his Budget, it is inevitable that it should be perused with the hope that it will yield some idea of the Chancellor's intentions. That, indeed, is the way in which commentators in the daily press have perused it. But as this issue will be published only three days before the Budget secrets are revealed speculation seems rather profitless. Instead the document can be studied to see whether the Government's actions in the past year satisfactorily controlled the economy and what clues it yields about the general economic intentions of the Government in the future.

As is recorded in the document, the rapid expansion of total demand and output which took place in 1959 continued into the early months of 1960 and led to such pressure on resources that the Government felt it imperative to adopt measures of restraint. Those measures included increases in Bank Rate, a slightly deflationary Budget, a call by the Bank of England for special deposits (an entirely new economic weapon), and restrictions on hire purchase transactions. Those actions did, indeed, check the rise in home demand; but unfortunately export trade did not continue to flourish but fell away from the peak levels reached in the early months of the year and imports rose so that there was a heavy deficit in the country's overseas trade. Certain questions ought surely to be asked now of the economists. First, does checking back home demand have any such desirable consequences as the encouragement of exports? It was certainly hoped that it would. But does not the evidence suggest, if there is any connection at all, just the opposite conclusion? Certainly it seems very unlikely that the effect could be immediate; because the creation of new markets abroad takes years rather than months of effort and even to bring about an increase of the demand in an established market may take very many months. Furthermore will not a business man argue that if an attempt is made to enter an export market just when home demand has been artificially restricted then it is rather likely to be just when home sales have been allowed to recover that the new export demand will develop, thereby creating a situation of embarrassingly high demand? Is it not more likely that the management of a firm will decide to enter upon export business quite independently of any action the Government may decide to take in the home market? It may well be that firms are less likely to seek orders abroad when they know that an unfulfilled and growing demand at home is dammed up by Governmental restrictions; more likely to do so if they think the home market is approaching saturation. Then the quite different question needs to be put whether it is reasonable for the Government to attempt to damp down demand by altering hire purchase rules. The effect of such an action is not general; it affects particular classes of goods and particular firms. There is very little evidence of much movement of labour out of the industries and firms affected and into others short of labour. As the "Survey" itself puts it "towards the end of the year there were some signs that the pressure of demand for labour was easing, but these were mainly confined to the motor industry and other industries producing consumer durable goods. The difficulties in these industries were met in 1960 largely by short-time working rather than by discharges. Thus shortages of labour in other industries were not alleviated by a re-deployment of labour." Under such circumstances it must be doubted whether any advantage was gained by imposing the restriction; for depressing the demand for particular products, a somewhat unjust proceeding in itself, seems only to have increased the demand for other products without appreciably relieving the pressure upon the hard pressed industries which produce them.

One development during 1960 over which the Government had little control was ominous. In the second half of 1960 earnings were 6½ per cent higher than in the second half of 1959; but national productivity "did not rise as much and, moreover, cannot be expected, on the basis of experience, to rise at so high a rate over a period of years. . . . If increases in pay continue to outstrip the rise in national productivity, the pressure on costs and prices will be intensified and ability to export will be impaired." There are, of course, other features of the economy which are outside Governmental control. "The motive power for economic growth cannot be created by the Government alone. Much will depend on the determination of industry to adapt itself to changes in demand, to make greater use of facilities for education and training at all levels and boldly to plan investment for increased production and reduced costs. . . . Finally, for a country in the international position of the United Kingdom, it is axiomatic that the growth of the economy must be interlocked with the growth of exports — otherwise the balance of payments situation is bound to frustrate growth and force a reversal of direction. Endeavours by Government and industry to foster the growth of the economy will succeed only if they are designed to improve the country's competitive power."

"ENGINEERING & MARINE" EXHIBITION

The twenty-third Engineering, Marine, Welding and Nuclear Power Exhibition opens at Olympia on Thursday next to show the latest products of about five hundred leading manufacturers. The arrangement of the exhibition follows closely the lines of those held in past years and preliminary details which have been received indicate that the exhibits will be both varied and interesting. As might be expected with the increasing number of shows devoted to the products of individual groups of manufacturers the overall coverage of this exhibition has been somewhat reduced — a noticeable absence this year will be many firms in the electrical industry. Nevertheless it would appear that the vacancies have been well filled by concerns new to this exhibition In addition to its commercial value this exhibition is also of considerable educational value to the many young engineers who are increasingly devoting their time to specialised branches of industry. Specialisation is often apt to restrict a young man's outlook and if he can take advantage of acquiring a broad insight into new industrial products and developments such as will be possible at the "Engineering and Marine", it will be to his benefit in later years, when he will probably require a wider knowledge of industry in which to apply his specialised training.

Much development now-a-days consists of the improvement in detail of proved designs; and it appears at this stage that but little plant of really new design will be exhibited. However exhibitors sometimes like to keep the revelation of a new product for Opening Day and there may prove to be more new products than first reports suggest. Visitors to Olympia will note the closer attention which is being given to the development of ancillary equipment and the use being made of improved materials and processes to increase both the efficiency and effective working life of plant. Many newer controls, both electrical and hydraulic, to be shown, will demonstrate the trend towards simplifying operation, increasing safety and giving more efficient working of equipment — particularly in the marine and welding fields. Our first article on the exhibition — page 581 — is based upon preliminary information received from exhibitors and it gives a good impression of the wide range of plant and equipment to be shown.

NUCLEAR ENGINEERING CASUALTY

The recent announcement that the Langley factory of the Hawker-Siddeley Nuclear Power Company Ltd., is to be closed down gradually is a sad symptom of the depression that has been afflicting some sections of the nuclear power industry. According to a statement issued by the parent company "this action has been forced on the Hawker Siddeley Group as a result of the uneconomic trend that has developed in this industry." The shut-down at Langley is to be effected progressively during the next few months, and the company will fulfil all its present commitments. Some of the work, it is stated may be transferred to other factories in the Group, but otherwise none of them will be affected by the closure of the Langley works. In particular the factory at West Howe, Bournemouth, which employs 130 people, mainly on contract work for the United Kingdom Atomic Energy Authority, will remain active.

The Langley factory has specialised in the development and design of reactors for research and power generation with particular emphasis on ship propulsion. On the research side there is the "Jason" reactor, three versions of which have been built — one has been delivered to the U.K.A.E.A., another has been exported to Holland, while the original "Jason" is installed at the maker's factory where it has been in continuous use for nuclear research and design work. Quite recently we referred in our columns to experimental work which has been done on the Langley "Jason" with a view to producing a design uprated from 10kW to 100kW. As for power reactors, the company has been in the field for organic moderated reactors for ship propulsion.

What is to become of projects such as these? Enthusiastic and highly-qualified research and design teams have been patiently built up. Now, presumably, the time has come when the group has had to decide whether it can afford to keep these teams in being without any orders and therefore without much prospect of seeing any return on its considerable outlay. Undoubtedly the protracted delay in the anxiously awaited governmental decision on the ordering of a nuclear propelled tanker must have influenced the Hawker Siddeley decision to close the Langley works. We can appreciate that the Government may have serious doubts about the economics of nuclear propulsion for merchant ships. But we wonder why, if it had such doubts, was it persuaded to invite tenders for a nuclear powered ship?

SALES DRIVE BY N.C.B.

An intensive sales campaign has been started by the National Coal Board with the idea not only of retaining existing customers but, if possible, of developing, also, new markets for industrial and domestic coal in this country. For some time the oil industry has been making inroads into the coal market, and in announcing the campaign Mr. Alfred Robens, chairman of the N.C.B., said that, although it was appreciated that each year some business would be lost to oil, a major effort was to be made to make up this loss by sales in other directions. The aim was to get the demand for coal to a level of 200 million tons a year and to keep this demand constant.

Initially the campaign seems to be directed towards the domestic market and to show how, by the replacement of old-fashioned appliances, fuel bills can be appreciably reduced. To this end a new domestic boiler has been developed and will be made by a number of firms to N.C.B. specifications. Many customers having little storage capacity for fuel have been lost in the past owing to lack of supplies of coal in the winter and to overcome this trouble it is proposed to establish large stocking sites at strategic points throughout the country. In the future coal will not be stocked at the mines, where it is locked up by transport difficulties in inclement weather. All coal will be transported directly for storage at the sites whence it will be readily available for shorthaul distribution to local suppliers and consumers, irrespective of weather conditions. A third important policy step in connection with the sales drive is directed towards attaining price stability by concentrating on increased productivity at the mines themselves.

It is to be hoped that this campaign will achieve a measure of success—for it must be remembered that the country has invested no less than £900 million in the mines since vesting day and that its annual turnover is almost as much. Further the wage bill of the industry is nearly £500 million a year and it spends £250 million a year on machinery and supplies, mostly in this country. The moment chosen for the start of the campaign may

turn out propitious. The swollen coal stocks in this country have shown in recent months more than a seasonal tendency to fall and industrially output is rising fast with the consequent promise of greater demands for coal at power stations and within industry itself. Despite competition from oil it would not be altogether surprising were it to turn out in some years' time that the rate of production of coal fell once more below the demand for it.

LABOUR PARTY AND SCIENCE

No political party can have the monopoly of being right, or, for that matter, of being wrong either. Reading a pamphlet "Science and the Future of Britain" issued by the Labour Party we find in it what appear to us to be many half-truths, some naïve ideas, and a failure, common to all political parties, to distinguish properly between science and engineering. There seems to us to be an illusion about the benefits that central direction can bring. This is the illusion that led to the setting up of nationalised industries. The fact, we suggest, is that an industry is as energetic, as far-sighted and as bold, or as complacent and flaccid, as the men who work in it; and that as no one else has the necessary knowledge and experience no imposition of control from above can make much immediate difference. Rather probably some of the economic troubles being experienced by the railways and the coal mines may be traced to a shortage within those two industries of high quality staff. It may take a generation to remedy the deficiency. What a Government can do is to make the industrial climate favourable for the incursion into backward industries of new, young and energetic blood. But attempts at control from Whitehall or from a Whitehall-dominated Board are likely to bring to bear on the wretched industry concerned undesirable political pressures. Were a single body to control the destinies of the whole of the fuel and power industries, for example, would it not be inevitable that "pressure groups" would activate members of Parliament to favour the causes of coal, gas, oil, nuclear power or electricity? The Government would inevitably be tempted to meddle for political reasons in affairs that ought to be ruled, and are much better ruled, by economics.

But though it is possible to be critical of the document there can be no doubt of the energy of the thinking behind it. The need for individual industries and indeed for Britain as a whole to "pull up its socks" is more urgently felt, we think, by socialists than by conservatives. For that reason we sometimes think it might be no very bad thing if the Labour Party were to win the next election. But the chance seems remote. For that party looks to be running inexorably towards a split. What is so irritating about that situation is that to many engineers the threatening split appears to be based upon an argument over something relatively unimportant. For in relation to the challenge to this country to maintain its place in a world advancing technologically at an unprecedented rate, whether or not we should possess nuclear weapons is a minor matter. The argument can have no influence whatever on making plans for the future; for if nuclear war comes, whether we have nuclear weapons or not, the brutal fact is that this country is doomed. A great political party, we feel, should be able to tolerate divergences of opinion upon such a matter within its ranks. It is much more important that there should be an opposition energetic and imaginative and strongly critical of the pace of movement of the Government. For no one can feel satisfied about this country's performance in developing its productive resources and increasing its international trade over the last several years and it may well be true that the Government should bear part of the blame. The document under discussion is critical in several ways. It criticises plans for the education of scientists and engineers as quite inadequate to needs. It also criticises a number of other policies, for example those for road building, hospital building, for aid to overseas territories, for agricultural research, for fuel and power development, etc., as inadequate to needs; though how the cost in terms of the use of trained manpower and technical resources, not to mention cash, is to be met is not fully explained. We notice in the Labour Party a greater enthusiasm for the application of science than is to be found amongst conservatives. To some extent it is a little naïve; there is a tendency to want to organise science; there is a tendency not to see the difference between science and technology; there is a tendency to think of science as a universal panacea capable of providing an answer to every problem. But the energetic desire of the Party to see a greater proportion of the population of this country educated in science and engineering and to see the methods of scientific thinking more widely and better applied is surely to be applauded, not least by engineers. There are, of course, other values in the world than scientific ones. But it is in the fields of science and, more especially nowadays, of technology that understanding by the population as a whole is comparatively lacking. Were the socialists to drop their hankering after nationalisation and their irritating liking for control from Whitehall we might even recommend engineers to vote for them. But Hush! Nationalisation is not a very clean word nowadays amongst socialists. The Party might split on that issue too!

The Engineer—100 Years Ago (APRIL 12, 1861)

"TIME-GUN AT EDINBURGH CASTLE"

"It is expected that, before the close of the present month, the audible time-signal at Edinburgh Castle will be brought into daily operation. The time-gun is established in connection with the time-ball on Calton-hill, which was set up some years ago as a time-signal for the benefit of the city of Edinburgh and also for the port of Leith. It was found, however, that frequently the signal was invisible through fog or haze, and Mr. Hewat, a merchant in Edinburgh, some time ago suggested that the signal, which is worked from the observatory on the Calton-hill, should be connected, by means of an electric wire, with a gun on the Castle battery, which should be discharged simultaneously with the fall of the time-ball. This suggestion is now being carried into execution.

"The apparatus is now in progress of construction by Messrs. Ritchie, Edinburgh, and one part of it is to consist of a single strand of electric wire suspended from the Calton-hill to the Castle in one stretch of 1,400 yards, and which being elevated to about 100ft. to 120ft. above the level of Princes-street, will be quite invisible to the eye. The Directory map of Edinburgh and Leith about to be published for 1861-2 will be marked with a series of circles showing the exact time that will elapse between the discharge and the sound of the gun reaching any point on the map."

Mechanised Tyre Factory

A consortium of British companies under the name of Rustyfa, Ltd., has designed and equipped a completely mechanised tyre factory which will shortly go into production at Dneipropetrovsk in the Ukraine. This factory is designed to produce 2,000,000 tyres a year in all sizes up to the tractor and giant earthmover types. It has been built and equipped at a cost of some £14,000,000, and is the largest plant of its kind in Europe.

ONE of the largest and most completely mechanised tyre factories in Europe, which has absorbed approximately £14,000,000 worth of service plant and rubber and tyre manufacturing machinery supplied from Great Britain, will shortly be going into production at Dneipropetrovsk, near the Dneiper River in the Ukraine. The plant has been supplied by a consortium of British companies operating under the name of Rustyfa, Ltd. Member companies of the consortium are : Mather and Platt, Ltd. ; Simon Handling Engineers, Ltd. ; Crompton Parkinson, Ltd. ; David Bridge and Co., Ltd. ; Francis Shaw and Co., Ltd. ; and Lancashire Dynamo Holdings, Ltd. The factory has been laid out and equipped according to specifications recommended by Dunlop Advisory Service, Ltd., the consultant to the consortium, which has also been responsible for supervising the plant and machinery during course of manufacture and for inspection before dispatch. The design and layout of the plant is arranged to give a continuous and directional flow of work through the various processes ; it is fully mechanised with a high degree of automation. The planning and provision of the whole of the various mechanical handling and conveying systems was undertaken by Geo. W. King, Ltd., of Stevenage, Herts., in close co-operation with Dunlop Advisory Service, Ltd.

The factory, built on a 79 acre site, has been designed to produce 2,000,000 tyres per year ranging in size from the small car tyre to the tractor and giant earthmover types. The main manufacturing building is approximately 1170ft long by 570ft wide with a three-storey section giving a total floor area of 765,000 square feet. An administrative office block is situated alongside the east end of the manufacturing building, the first floor being connected by bridgeways. Ancillary buildings include tyre test house, research laboratory, maintenance machine shop, and houses for compressed air plant, water pumps, electrical switchgear, &c. A separate building, having a total floor area of 326,000 square feet, to one side of the main manufacturing building accommodates stocks of raw materials ; and a section of this building is also arranged to hold stocks of finished tyres awaiting dispatch.

Particulars of the conveying and handling system installed at the new factory have been released by Geo. W. King, Ltd. As can be seen from the flow diagram we reproduce, raw material is conveyed into the main building via bridgeways ; fabric rolls are brought directly to the centre of the plant ; and raw rubber is delivered to the beginning of the manufacturing process at the extreme end of the building.

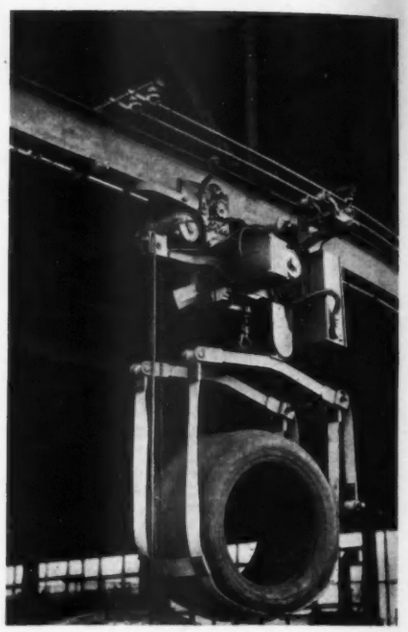
Fabric rolls, each weighing ½ ton, are conveyed at a rate of twelve per hour to the fabric lines by a semi-automatic overhead runway which is in the form of a closed circuit incorporating five electric twin-lift " Marvex " hoists.

The rolls are attached by slings at a loading station in the stores and by a preselector switch the operator directs the hoist to any one of three unloading stations in the main building. To ensure regular spacing of the hoists and to prevent them from approaching each other beyond the minimum distance, the electrical supply busbars are " broken " for a section between each station. This section becomes dead when the station in front is occupied. As a further safety precaution, hoist travel is not possible until the hook is raised to its maximum position. Each hoist starts its journey at a slow speed, changing to top speed after a short distance, and similarly the speed is reduced before stopping.

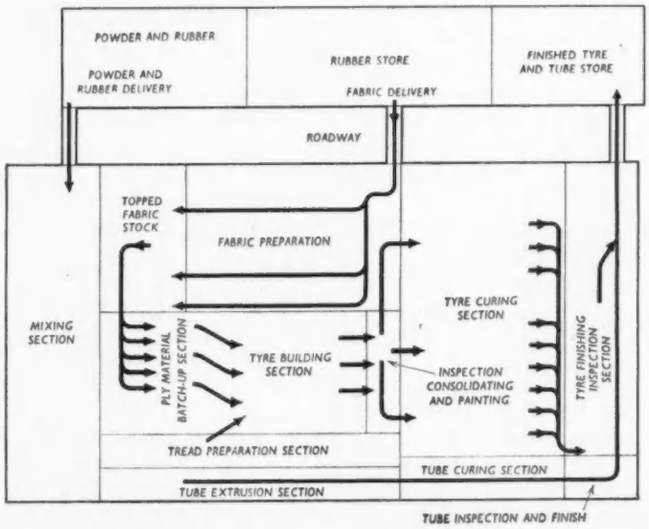
Natural and synthetic rubber is brought into the building by a " Dual Duty " overhead conveyor system. The natural rubber bales handled weigh 240 lb each and measure 28in by 20in by 17in ; the synthetic rubber bales weigh 75 lb each and measure 28in by 14in by 8·7in. The rate of intake for both natural and synthetic bales is approximately 10 tons per hour, the bales being conveyed in basket carriers designed to hold two bales of natural rubber, or six bales of synthetic rubber.

The carriers are dispatched by push button preselection to one of four unloading stations, the natural rubber first being directed to a depolymerisation plant, where electrical treatment brings it to the temperature required for processing.

At each unloading point, conveyor loops are provided with a number of waiting indexers so that it is possible to dispatch a batch of bales of any type of rubber and the whole batch are received before any work is begun on them. As empty carriers leave the unloading loops the preselection peg is cancelled and they are returned to the stores building for reloading. At two unloading stations, an elevating table is used to raise the bales out of the carrier. At the other stations, where it is necessary to keep the conveyor at high level, a drop section is incorporated in the " Dual Duty " conveyor, which lowers the carrier over a fixed roller top platform. At all unloading stations the air-operated rams, shown in the accompanying photograph, are used to push the bales clear of the carrier. At two bale cutting machine stations, air-operated turnover frames are provided which turn the bales on edge ready for cutting. At two pelletising machine stations, auxiliary belt and powered roller conveyors take the bales to the hopper of the machine.



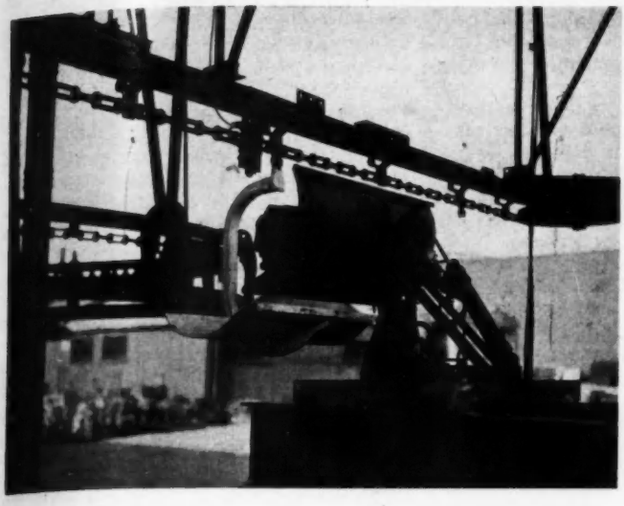
Semi-automatic overhead runway system for removal of green covers from band building machines



Flow diagram of mechanised tyre factory for U.S.S.R.

Rubberised Fabric Handling

After the various fabrics have been treated on two process lines and passed through calenders for rubber topping, they are rolled with fabric liners inserted for protection before being conveyed to stock racks from where they are called as required. Passing the rolls, each weighing 25 cwt, from the two fabric lines to any of eight storage racks at approximately twenty-eight rolls per hour involves a complicated system of cross-over lines and junctions. A semi-automatic overhead runway forms the basis of the handling system, with three " Mammoth "



Automatic loading station for rolls of rubber from strainer slabber machine to power-pulled conveyor

hoists at each of the two fabric lines. Operators at the two pick-up points select a storage rack to which the roll is to be sent by press button control on hoists. After loading the roll and operating the selector switch, the operator presses the automatic traverse button which starts the hoist cable winder. When the hoist arrives at the preselected storage rack it stops and its push-button panel is automatically lowered to enable the operator to take over manual control for positioning the roll. Incorporated in the runway is a main junction directing the hoists to three principal tracks where they are further divided to cover all the storage racks. All hoisting units are returned through a by-pass route to one point where liners used in the rolling are picked up and taken to the end of the topped fabric line.

The rolls are removed from the storage racks and delivered to six bias cutting machines by a semi-automatic runway on which are mounted four special double hoisting units. Each unit comprises a "Mammoth" hoist block which handles the rolls of fabric and empty liners, and a small auxiliary hoist for handling empty "boxes" or shafts, around which the fabric is rolled, at the bias cutter machines. The units travel automatically between the loading area and the bias cutter machines. When an operator at these machines requires a new roll he presses a call push button which lights up a lamp on an indicator board at the loading base so that the required type of fabric roll may be loaded on to the main hoist sling. When the hoist arrives at the bias cutter machines the operator takes over manual control and lifts the empty box from the bias cutter machine with the auxiliary block. He then lowers the new full roll into position and picks up the empty liner with the main block ; finally he lowers the auxiliary block to place the empty box into the position vacated by the liner, raises both slings and restarts automatic travel for return to storage base. The system has been designed to feed fifteen rolls per hour, giving a cycle of four minutes to each roll.

After passing through the bias cutting machines, the material is "batched" in smaller rolls of ply material, and stored in powered vertical storage racks of which there are sixty, one for each type of ply material. The racks, each designed to hold eighteen rolls at 224 lb, consist of two endless lengths of heavy-duty roller chain fitted with special attachments to receive the fabric roll box ends. These racks can be seen in course of assembly at the maker's works in our illustration.

Tyre Building

The ply rolls are delivered to band building and single ply tyre building machines by a "Dual Duty" light overhead conveyor. Any combination of the sixty different types of rolls held in storage may be required at any of the tyre building machines. In the twin-hook carriers a roll is located by the box ends held in vee slots. Each carrier is suspended from a pair of trollies by bars containing preselection pegs. All carriers are given an identification peg setting according to the type of ply material to be put into the carrier, a set number of carriers being allotted for each of the sixty varieties. After loading, the carriers begin circulating around one of two tyre building area conveyors according to whether the material is for single ply or band building machines.

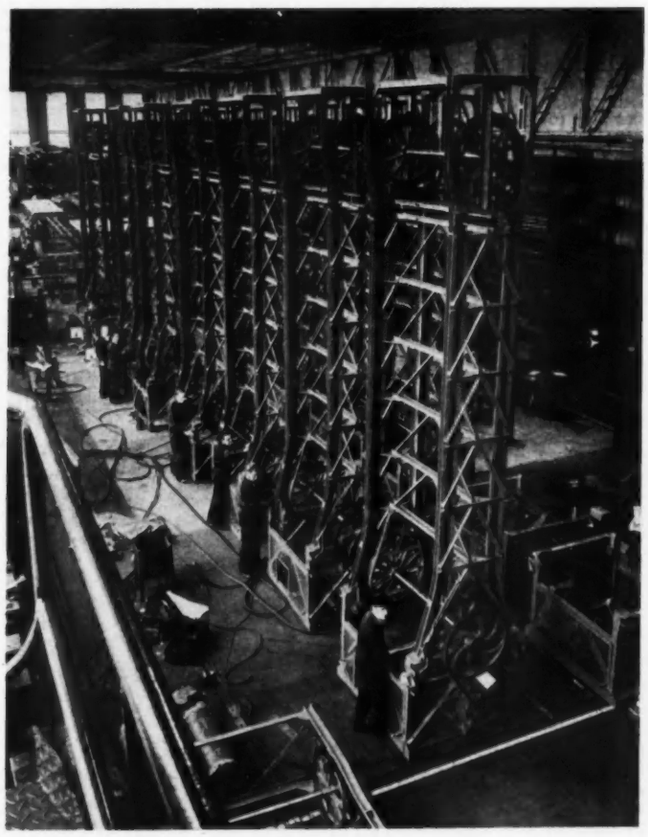
An auxiliary unloading loop is provided at each tyre building machine to hold one carrier at a time. When a service operator requires a roll of material he uses a selector switch and push buttons mounted adjacent to the unloading loop to send a call to an electrical peg setting unit mounted on the circulating conveyor. The next carrier with the required material to pass through this unit is automatically directed on to the machine loop from which the call was made.

Empty carriers leave the liner conveyors and, continuing in the main system, pass to the auxiliary loading loop adjacent to the storage rack holding the type of material allocated to it.

The treads are brought to the tyre building machines by an overhead belt conveyor system incorporating vertical "hugger" belts. In this system four different conveyors feed the four lines of tyre building machines. Each line consists of an adjustable inclined section, a fixed inclined section and an overhead horizontal set of conveyors spanning the machines. Above each machine a short length of hinged roller conveyor feeds into the vertical "hugger" belts leading down to the machine table. Each vertical "hugger" belt unit is so positioned that upon demand by the machine the hinged roller section will lower for the tread held on the adjacent horizontal conveyor to pass down to the machine table. Upon discharge, a limit switch at the lower end of the unit is operated and the hinged roller section returned to the horizontal. As the treads are "called" into the tyre building machines, the appropriate overhead belts automatically restart to feed forward the following treads and fill up all vacant positions.

Tyre Removal

Green tyres from the truck and car building section are removed by a "Power Pulled" overhead monorail conveyor equipped with saddle carriers. Loading is by hand, the conveyor passing at a low level between the rows of machines. An automatically



Powered vertical storage racks for rolls of ply material under construction

operated unloading table is provided at the inspection bay. For larger tyres a semi-automatic runway system is provided with six hoists which normally travel automatically around a complete circuit in one direction, stopping only at the unloading point. When an operator is ready to load a tyre he uses a push button which causes the next hoist block to stop at his machine.

Delivery of the green tyres from the inspection and painting area to the curing presses is carried out by three separate overhead conveyor systems. Two " Power Pulled " conveyors deliver the truck and car tyres to 40in and 55in presses, while the heavy-duty tyres destined for the 75in presses are handled by a " Dual Duty " conveyor.

The presses are arranged in rows back to back, with the overhead delivery conveyor passing between them. Each twin press has its own feeder conveyor, which consists of a fabricated tubular steel frame, mounting a double chain conveyor, to which a number of cradles are attached. The feeder conveyor is electrically interlocked with the curing press and the " Power Pulled " delivery conveyor, and works intermittently to discharge a pair of tyres into the press on demand from the automatic press cycle. With each movement of the feeder conveyor, a pair of empty cradles is brought in position under the overhead delivery conveyor. When the correct size tyres pass along the conveyor, air-operated ramps cause the tyres to be rolled out of the carriers into the waiting cradles.

Cured tyres are discharged automatically from the back of the presses on to take-away belt conveyors, and delivered to the finishing department. From the point of inspection and painting after building, the tyres are handled entirely automatically until arrival in the finishing section.

The larger tyres are delivered to the 75in curing presses on the " Dual Duty " conveyor system from which they are suspended on special grabs. These grabs are made to be readily detachable from the conveyor load trollies, to open and close, for picking up and releasing the tyre, by electro-mechanical remote control. The conveyor provides storage of one tyre per press at the unloading area, and a bank of storage at the loading stations, totalling approximately three hours' stock of each size of tyre. As a tyre is used at the presses, a " call " signal is automatically transmitted to the storage bank and a replacement released.

An overhead conveyor removes tyres from the finishing section in the building through a bridgeway to the stores where a number of unloading units are installed so that the tyres may be unloaded at the most convenient station.

Royal Institution of Naval Architects

ANNUAL SPRING MEETING

No. II

AFTER the President's address the meeting continued with the reading of Paper No. 1 which was :

INTERNATIONAL CONFERENCE ON SAFETY OF LIFE AT SEA, 1960

By R. J. SHEPHERD

SYNOPSIS

International Conferences concerned with the Safety of Life at Sea have been held on three previous occasions, and a paper by G. Daniel, Esq., C.B.E., presented to this Institution in 1949, gives the historical background to the 1960 Conference which was convened in London by the Inter-Governmental Maritime Consultative Organisation, designated I.M.C.O.

Fifty-five States were represented at the Conference and nine Inter-Governmental Organisations were also represented, nearly 600 persons taking part. By comparison with the corresponding figures for the 1948 Conference, thirty-four and seven, with about 280 persons taking part, it will be seen that this was a considerably bigger Conference than any previously held. The increase in State representation was undoubtedly due to the large increase in the number of governments interested in maritime affairs, and certain Commonwealth countries and other young States played a larger part in the proceedings.

So early a review of the decisions of the 1948 Conference was found necessary primarily because in the intervening years we have seen the successful development of the inflatable liferaft and the introduction of the nuclear ship. Further, anxiety was felt following the collision between the " Andrea Doria " and the " Stockholm," that adequate steps had not been taken in earlier Conventions to secure maximum safety in such an event, and the alarming frequency of the collisions between large ships in certain waters seemed to lend support to this standpoint. The strengthening of many requirements in the new Convention is a reflection of this anxiety and of a generally held determination to take whatever steps are reasonably practicable to obviate the consequences of such events. It was felt that there was need to review the requirements for fire-fighting and the regulations governing the carriage of grain, and undoubtedly these feelings have been stimulated by the frequent outbreaks of fire in ships and by the world-wide shipbuilding activity in the building of ships specially adapted for the carriage of bulk cargoes. In some countries it was thought that the scope of the Convention should be extended to include fishing vessels, and a number of delegations wished to see regulations made to cover intact stability and subdivision of both cargo ships and fishing vessels.

It is impracticable within the compass of a single paper to review all the decisions of the Conference, and the paper is mainly concerned with the principal decisions relating to the design, construction, and equipment of ships.

DISCUSSION

Mr. J. Lenaghan : The paper must be little more than a summarised account of some of the decisions of the conference ; nevertheless, it allows us to grasp the range and relative importance of the changes made. There can be little doubt that the safety of ships will be improved by the strengthening of many requirements in the Convention. But are we not approaching the stage where, by comparison with other standards ruling to-day, ships are found to be very safe, and would it not be proper to consider the economic implications of each change? I have in mind the new provisions that cargo ships will be required to undergo periodic surveys of hull machinery and other equipment and to carry certificates of their surveys.

If any comfort is to be derived from the new regulations for passenger ships, it is that many of the adoptions have already been regarded in the United Kingdom as normal practice before becoming now a legal requirement. The opportunity might have been taken to rationalise the factor of subdivision, making it either 1, 0·50 or 0·33, for many would feel more confident in a ship's safety if that factor could be treated on a one, two or three-compartment basis and would have been prepared to accept more onerous permeability conditions to achieve this. Calculations would then require two realistic sets of figures instead of two sets where legal acceptance appears to be their only excuse for existence. Investigation of side damage is very necessary and its assessment is extremely important if any sense is to be made of the requirements of collision protection for nuclear ships.

The United Kingdom proposal for the recognition of inflatable liferafts was accepted by the conference; however, although embarkation of passengers into liferafts on deck and the lowering of them into the water has been demonstrated successfully in protected water, much work is still to be done in this field. Concessions are always welcome and the disappearance of grain shifting boards in ships specially designed as " bulk carriers " should cut the cost of the preparation of these ships for grain cargoes to a small amount and result in considerable economic gain.

The inclusion of provisions in the Convention for dealing with nuclear propelled ships is of particular importance, even though the general adoption of this form of propulsion for merchant ships seems far away. The safety measures outlined for these ships provide evidence that the sooner the U.K. has a merchant ship in service with nuclear propulsion, the better. These safety regulations impose a severe economic penalty on the operation of a nuclear ship, and without experience with such ships there is little hope of any relaxation in either the basic rules for their construction or for their operation. Further, it is doubtful if any Government administration would feel happy to accept nuclear propulsion for a passenger liner without having first hand service experience with this form of machinery installed in tanker or other type of cargo vessel.

Mr. E. C. B. Lee : The most significant thing arising from this conference is the regulation introducing inflatable life saving equipment. In regard to rafts, the conference requires a cover. Naval experience is that it is better to have two covers, for in arctic conditions the survivors are warmed more quickly and do not suffer from condensation as with the single cover, and in the tropics the raft is much cooler, which is important when men are subjected to dehydration. There is nothing in the regulations about closing the tent. Recent Naval trials in very rough weather have shown that it is absolutely essential to maintain a tent completely closed to the weather. The heavy weather trials also show that a breaking wave will depress the arch system. Under the regulations the arch system does not count for buoyancy ; that being so, the tendency may be to skip the dimensions.

The regulations also specify a maximum all-up weight of 400 lb. The Naval trials showed that the greatest weight which can be handled safely under abandon-ship conditions is about 300 lb.

Mr. J. M. Murray, B.Sc. : This paper gives the differences between the 1948 Convention and the requirements of the 1960 International Conference. The new regulations will make matters rather more stringent for shipbuilders and shipowners three or four years hence, but shipowners will welcome the new regulations for the carriage of grain and the acceptance of the inflatable liferaft. Interest will naturally centre on the new requirements for the survey of hull, machinery and equipment of cargo ships, a duty which so far has been undertaken by the classification societies. I understand that the Ministry will delegate the survey of U.K. ships to Lloyd's Register, who will endeavour to see that shipowners are inconvenienced as little as possible by

this new regulation for a certificate which seems to be a rather superfluous document.

Coming to details of the Convention, the requirements for damage, stability and levelling arrangements are more precise than they were in the 1948 Convention. The requirement that levelling should be as quick as is reasonably practicable and that, in accordance with British practice, it should be achieved in fifteen minutes, is a useful advance, but the calculations required are tedious and a better approach would be that suggested by Dr. Solda in a recent paper to this Institution.

It is gratifying that the Bulkhead Committee's approximate method of calculating floodable lengths will remain general practice in this country, and in view of the great change which has taken place in the form of ships since Professor Welch instituted the system before the first world war, it is interesting that results obtained by this method were carried to within 2 per cent of the figure achieved by a direct calculation. This result is perhaps surprising and demonstrates that the parameters used by the Bulkhead Committee were well conceived.

Mr. R. V. Turner : I feel that one of the most significant results of the 1960 Conference was the decision to recommend to I.M.C.O. that studies should be made on two subjects vital to the design of passenger ships ; watertight subdivision and intact stability. It would appear that for the vast majority of passenger ships the amount of initial stability required in order to satisfy the damage stability conditions is more than adequate to deal with the most unlikely coincidence of unfortunate circumstances tending to heel the intact ship. Watertight subdivision and the associated damage stability therefore become the most important subjects to be considered in the I.M.C.O. studies.

It is to be expected that the Board of Trade method of calculating floodable length will again be subject to scrutiny. In this connection we have carried out a survey of the floodable lengths of a wide range of passenger ship types, ranging in size from that of a Windermere Lake steamer to the "Oriana," and have found that, excluding the points at the ends, the maximum deviation between the Board of Trade method and the Schirokauer method is 12 per cent. In only one case the B.O.T. method was favourable to the designer and in five cases the B.O.T. method was too restrictive by over 5 per cent at the maximum. These comparisons were made for 60 and 100 per cent only. It would thus appear to be to the advantage of all designers to carry out a direct method calculation in all cases so as to ensure that the B.O.T. method is not adversely affecting their designs.

No matter how thoroughly we in Britain understand the difficulties and disadvantages associated with some of the more advanced proposals, conveying this understanding to others can only be done effectively by presenting worked out studies—studies comparing two completely separate designs, each having precisely the same operating characteristics, but one design being in accordance with the present rules, the other taking as a fundamental premise the proposed changes in the rules. It is appreciated that comparisons of this kind might involve the full range of the ship designer's activities, including variation of dimensions.

Mr. B. N. Baxter, M.Sc. ; Ships registered with a classification society have to undergo an annual survey of hull, machinery and equipment in order to remain in class, and until the 1960 Convention comes into force the anomaly exists that there is no requirement either by international agreement or by British law for the periodic survey of machinery or equipment for cargo ships. It would appear that, although no intervals for surveys have been stipulated, these could well be done at the same time as the annual class or statutory load line surveys.

The Conference recommends that I.M.C.O. should initiate studies dealing with the intact stability of cargo ships. The losses of small cargo ships may be attributed in the main to one or more of the following causes : shift of cargo ; inadequate freeboard ; breaking of hatch covers and entry of water ; excessive rolling. Stability is the basic cause and therefore I regret that no standard of stability has been laid down in the 1960 Convention for smaller vessels.

The Conference recommends that I.M.C.O. should initiate studies on the extent to which it would be reasonable and practicable to apply subdivision to cargo ships. Again I regret that no standards have been adopted for subdivision in cargo ships, particularly when the requirements of the classification societies are such that a one compartment standard of subdivision could be obtained in many ships without the need to introduce any additional watertight bulkheads by simply adjusting the position of some of them.

A one compartment standard of subdivision in cargo ships has been sought for nearly a century and one of the main objections raised by owners is the difficulty of stowage. It is realised that this is often valid, and it is a pity that some positive incentive cannot be given to an owner, which will possibly enable him to comply with a higher standard of safety and at the same time accept some stowage inconvenience. The provision of adequate stability may well allow the carriage, as deck cargo, of many large items hitherto stowed in the holds.

It would be interesting to know how I.M.C.O. intends to study particular questions, for I understand that no large technical staff will be appointed to I.M.C.O. I would like to suggest that an appendix should be provided to the paper to trace briefly the steps leading to the actual Conference, together with other relevant information.

(To be continued)

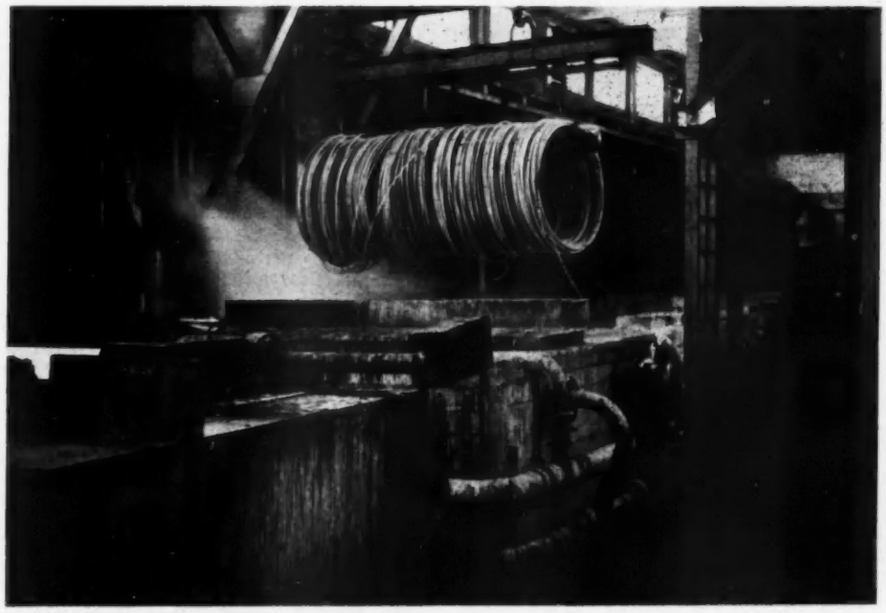
Forth Suspension Bridge Cable Wires

The two main suspension cables for the Forth road bridge will each consist of 11,618 parallel wires of galvanised high-tensile steel. When completed they will be about 24in diameter. Manufacture of the wire, totalling some 7000 tons in weight and 30,000 miles long, is nearing completion at Middlesbrough. To produce wire to the exacting specification laid down by the consulting engineers, new plant was installed, and a rigid quality control procedure instituted.

THE Forth road bridge is being built by the A.C.D. Bridge Company, a consortium formed by Sir William Arrol and Co., Ltd., the Cleveland Bridge and Engineering Company, Ltd., and Dorman Long (Bridge and Engineering), Ltd., and the consulting engineers are Mott, Hay and Anderson, in association with Freeman, Fox and Partners. Dorman Long (Steel) Ltd., Middlesbrough, was awarded the contract for the wire, the specification for which is :

Diameter	0·196in $^{+0·003in}_{-0·002in}$
Tensile strength	100 to 115 tons per square inch (with an average of not less than 102 tons)
0·2 per cent proof stress ...	75 tons per square inch minimum
Elongation	4 per cent minimum on 10in gauge length
Wrapping test	On three times diameter
Finish	Hot dip galvanise to B.S.S. 443
Straightness	A length of 100ft must be straight under a tension not exceeding 300 lb
Coil weight	850 lb to 1050 lb

Dorman Long's Lackenby rod mill supplies the raw material for the wire works, in the

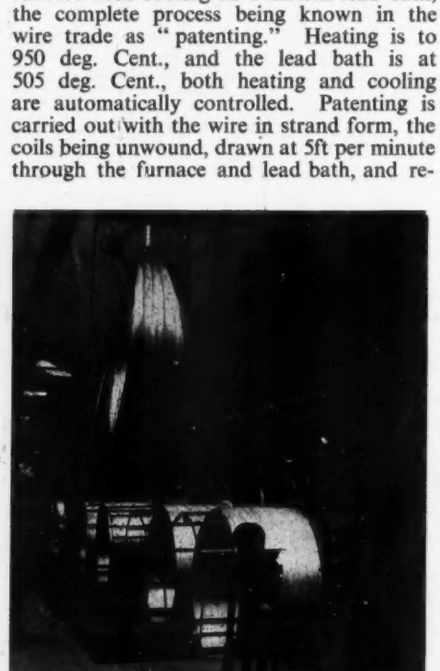


Hot rolled rod in coil form is pickled, phosphated and limed ready for drawing

A five-die wire drawing machine reduces the 0·400in diameter rod to the required 0·196in diameter

form of hot rolled, coiled rod 0·400in diameter with an analysis of 0·75 to 0·80 per cent carbon and 0·50 to 0·70 per cent manganese. This material has been produced at Lackenby under quality control which extends back through the intermediate rolling stages and the steel works to the blast-furnace. Immediately on receipt at the wire mill each coil is inspected at both ends for internal and surface defects, including decarburisation.

The first step is to heat-treat the rod. This is done in a 60ft, four-zone gas-fired furnace with cooling in a molten lead bath, the complete process being known in the wire trade as "patenting." Heating is to 950 deg. Cent., and the lead bath is at 505 deg. Cent., both heating and cooling are automatically controlled. Patenting is carried out with the wire in strand form, the coils being unwound, drawn at 5ft per minute through the furnace and lead bath, and re-coiled. Twenty-four coils are dealt with simultaneously. At this stage the physical properties required are: tensile strength, 72 to 78 tons per square inch; elongation, 8 per cent minimum on 10in gauge length; reduction of area, 30 per cent minimum.



On leaving the galvanising bath the wires are drawn up vertically for 35ft, then down to the coilers

To remove the scale prior to drawing, the rods are then pickled, in coil form, in dilute hydrochloric acid, water washed twice, and phosphate coated. A further water wash follows, and the coils are then lime coated and dried in a "flash" heater. Drawing is carried out in a Marshall Richards machine, the coils being end welded together so that drawing is continuous. A special paint is used to mark the welds, which are cut out after drawing, when the material, now reduced to wire, is coiled to the required size and weight. There are five draughts on the machine, using tungsten-carbide dies, which are water cooled, while air blast cooling is used on the wire as it coils on the drawing blocks. There is a total reduction in area of 77 per cent in the five passes, the individual reduction per pass being in the region of 25 per cent. Soap powder is used as the drawing lubricant, and the final exit speed from the machine is about 600ft per minute.

On leaving the wire drawing machine the material is to the dimensions, and has the physical properties, called for in the specification. The welds, marked by the paint which was applied before drawing, are cut out, and the wire is recoiled. Specimen pieces are cut from each end of every coil, and the first wrapping test is applied by wrapping a piece of the wire on its own diameter a minimum of seven times.

Galvanising is the next step. For this purpose the coils are again unwound, and the wires pass separately, in groups of eighteen, through the process. A preheater first dries the wire, which then passes through a low temperature lead bath, at 435 deg. Cent.; this both stress-relieves the wire and helps to burn off excess drawing lubricant. Pickling follows, in a hot dilute solution of hydrochloric acid, and the wire is next water washed, both by spray and by constantly-overflowing bath, to remove all traces of acid. The wire then enters a bath of hot proprietary flux, and passes immediately to the galvanising bath, where it is immersed in molten zinc at a temperature of 435 deg. Cent.; the zinc is 99·98 per cent pure.

On leaving the galvanising bath the wire passes through a wiping bed of oiled charcoal, which gives a smooth surface finish to the zinc coating. The wire is carried up vertically from the charcoal bed for a height of 35ft before passing over a 5ft diameter pulley and descending to a 5ft coiler. This movement in a straight line before coiling ensures that the straightness requirement will be met.

At this point the second of the wrapping tests is made, a piece being cut, as before, from each end of every coil, and wrapped on

To enable the wire to be supplied in the weekly quantities needed, it has been drawn in advance, and stored, protected by polythene and de-humidifiers

three times its own diameter. Here, too, the final inspection takes place. Inspectors from an independent inspecting authority, working on a shift basis with the production operatives, check the tensile strength, elongation, proof stress, zinc coating weight, strength and continuity.

Every coil is given three labels (as a safeguard against loss of, or damage to, a label in transit or storage), giving cast and coil number, diameter above or below nominal, coil weight and whether left-hand or right-hand wound. The last three details given on the labels will be necessary information for the bridge builders when the wire comes to be laid or "spun" into the cables (it is not spun in the normal sense, the wires being laid straight and parallel, but "spinning" is the term used to describe the making of the cable). Coils of different weights will be mixed in order to "break" the wire joints in the cable, and the information about the "handing" of the coils will be required when they come to be laid. Different wire diameters, too, will be mixed to even out the final diameters of the cables, for although the total tolerance on a single wire is only 0·005in, when 11,618 wires are put together in a cable, the differences could add up to a significant figure.

Because the wire is drawn at a rate of about 150 tons per week, and it will be used at some 800 tons per week when cable spinning starts, arrangements were made by the manufacturers to start production well ahead of the time when the wire would be needed, and to hold it in stock. For stocking, the finished, inspected and labelled coils are moved by pin truck to a nearby building, where they are stacked in a form well described by its trade name of "plaiting," on timber baulks laid on a polythene sheet. When a stack of suitable size has been built up, a second polythene sheet is laid over it, two de-humidifying units are placed among the coils, and the edges of the plastic sheets are heat sealed. In this way, the finished wire can be held indefinitely without deterioration.

ENGINEERING & MARINE EXHIBITION—No. I

The Engineering, Marine, Welding and Nuclear Energy Exhibition which opens at Olympia, London, on Thursday next, April 20, will be open daily until Thursday, May 4. Some 500 firms will be represented and the descriptions given in the pages which follow are based upon preliminary details received from exhibitors. As in previous years the exhibition provides an opportunity to see the latest developments amongst a comprehensive range of modern equipment, prime movers and accessories for the engineering, marine, nuclear and welding industries.

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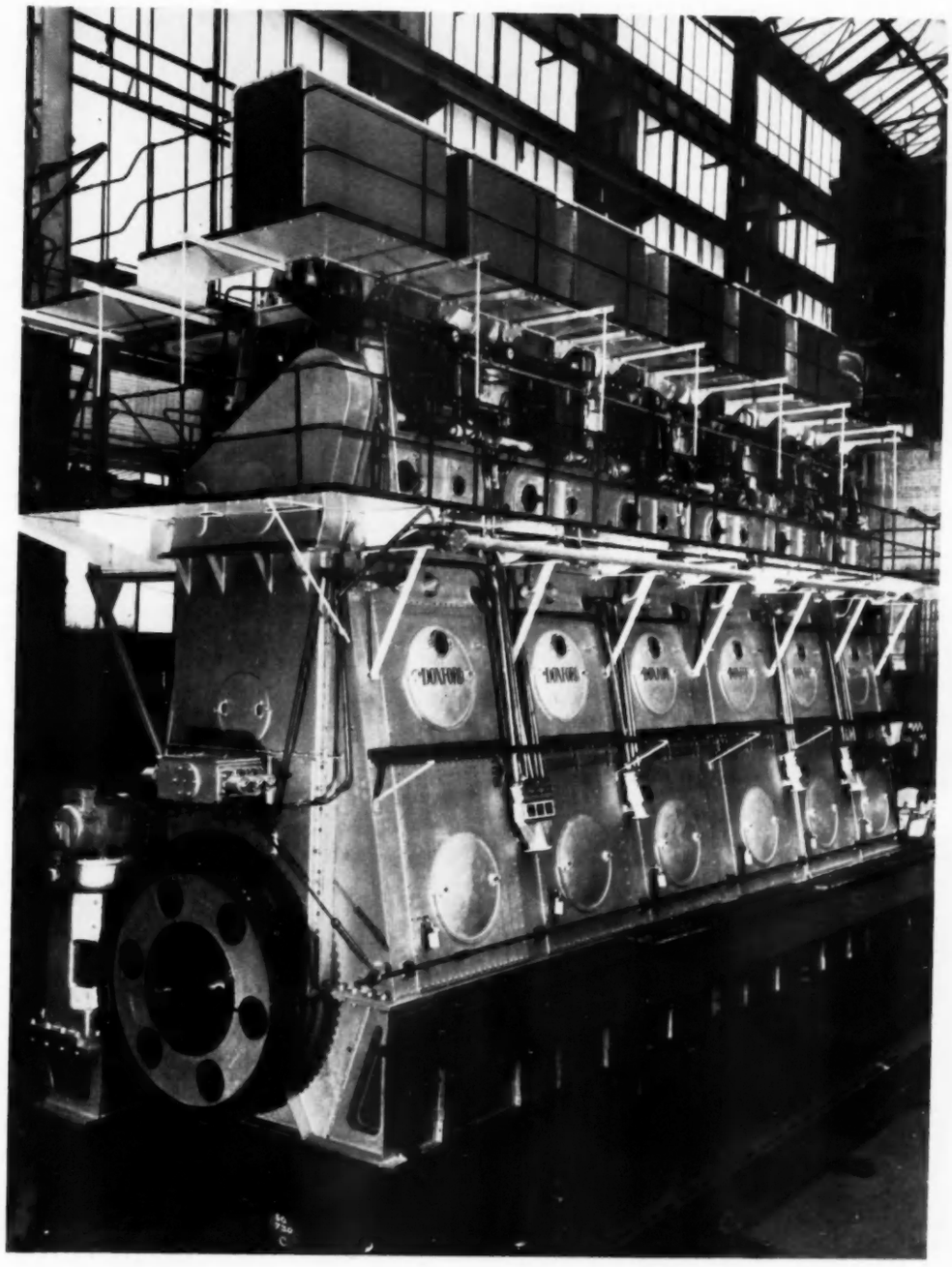


Six-cylinder 10,000 b.h.p. Doxford marine diesel engine installed on oil tanker "Montana"

W. H. Allen Sons and Co., Ltd.

The largest exhibits of W. H. Allen, Sons and Co., Ltd., Bedford, will be the 750kW back-pressure turbo-alternator for marine service and the 360 b.h.p. dual-fuel engine and alternator illustrated on this page (Fig. 1). The turbo-alternator is one of two sets being supplied by the company for installation in a 37,000-ton tanker for the P. and O. Group fleet. The 13,500 r.p.m. turbine operates with steam at 575 lb per square inch gauge, 830 deg. Fah., exhausting against a pressure of 20 lb per square inch. It drives the 750kW, 440V, three-phase, 60 c/s alternator at 1800 r.p.m. through Allen-Stoeckicht gearing.

The impulse turbine has one two-row Curtis wheel and six Rateau wheels. Its cylinder is secured to the high-pressure end bearing pedestal by an arrangement of radial pins whereby the hot cylinder can expand radially outwards without distorting the pedestal or disturbing the shaft alignment. Axial movement is catered for by sliding feet on the pedestal. A vertical auxiliary shaft, gear-driven from the turbine rotor at the high-pressure end of the turbine, drives the leverless oil-relay governor and the governor-oil and lubricating-oil gear pumps. Four main nozzle groups have individual oil-operated control valves, each group being embodied in its own "inserted steam belt." The four steam belts, each with its integral throttle-valve chest, are carried separately within the high-pressure end of the turbine cylinder and are free to expand independently. The four throttle valves are operated by four oil-relay cylinders, disposed with their centre-lines horizontal, thus allowing for cool operation of the relay cylinders with a diminished risk of oil carbonisation and resultant sticking of the spindles. In addition to the four control valves there is an oil-operated emergency valve with a steam strainer and a separate main steam stop valve mounted on a steam chest.

The turbine drives the alternator through a flexible coupling and an Allen-Stoeckicht epicyclic reduction gear. For this double-helical planetary gear the flexible coupling forms the sun wheel. The planet carrier of the gear is rigidly coupled to the alternator rotor shaft and is overhung from the gear case bearing, which forms the second bearing of the alternator rotor and also locates the axial position of the rotor. This design of gear results in a compact arrangement of the plant and effects a considerable saving in space and weight over a machine incorporating a side-pinion parallel-shaft gear.

The 250kW dual-fuel engine-driven generating set (Fig. 2) comprises a five-cylinder, 428 r.p.m., 360 b.h.p. engine directly coupled to a 312·5kVA, 0·8 power factor, Allen self-regulating alternator. This type of dual-fuel set is constructed in three to eight cylinder models, in normally-aspirated form with power outputs of 213 to 664 b.h.p. (147kW to 456kW), and is representative of the firm's range of engines which, as straight diesel units, are additionally available in both pressure-charged and intercooled form, for industrial applications with power outputs of up to 1264 b.h.p. (872kW).

The four-stroke airless-injection, compression-ignition engine shown is arranged for continuous operation on natural gas with only a minimum requirement for liquid pilot fuel which, in service, will be crude oil. It is designed to start up as a straight diesel engine when the fuel pumps, one for each cylinder, are controlled by the hydraulic governor, the gas being completely shut off. Following this, a manual change-over to dual-fuel operation is made, whereupon a hydraulically-operated main gas admission valve is opened and individual gas metering valves, one for each cylinder, are brought under the control of the engine governor, the fuel pump rack rod then being locked in the "pilot" position. To facilitate utilising crude oil for pilot ignition purposes, the engine is equipped with a ring main through which the fuel is continuously circulated, hot-water-jacketed duplex oil filters being provided in the system, to ensure that the fuel is heated to a temperature and suitable viscosity for efficient combustion.

The engine is arranged for remote push-button starting, and all essential services such as cooling water, fuel, lubricating oil and starting air must be properly available before the starting cycle can be completed, thus safeguarding the installation. Following start up, separate alarm and shut-down circuits automatically become effective, covering cooling water temperature and pressure; fuel temperature and pressure; lubricating oil temperature, pressure, high and low levels; gas pressure; exhaust temperature; and extreme load conditions.

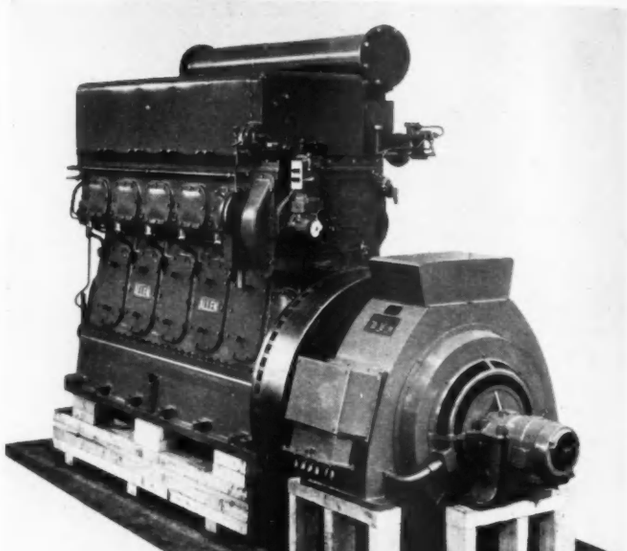


Fig. 2—360 b.h.p. dual-fuel engine driving 250kW, self-regulating alternator—Allen

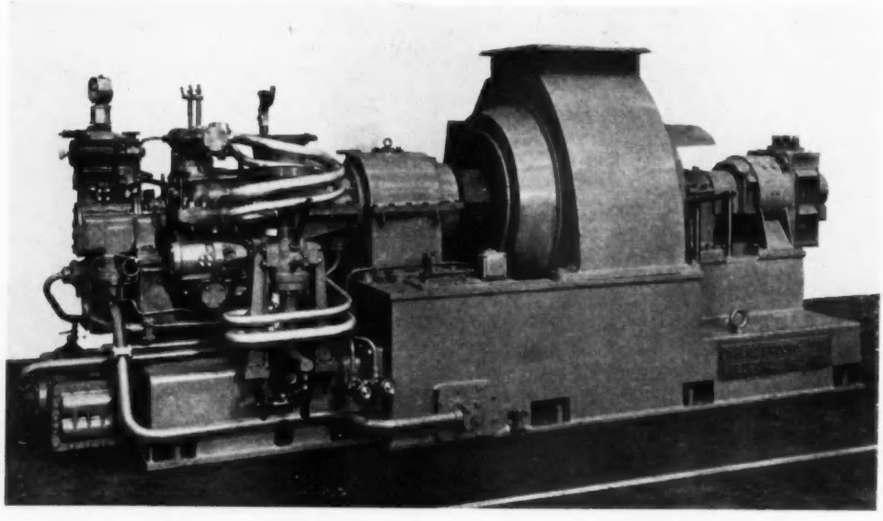


Fig. 1—750kW, epicyclic-geared, back-pressure turbo-alternator for tanker service—Allen

In addition to the 750kW and 250kW alternators coupled to the steam turbine and diesel engine, a third machine is to be exhibited, a 550kW brushless alternator of new design. This machine is a development of the conventional alternator–d.c. exciter combination, incorporating shaft-mounted rectifiers in place of the alternator sliprings and exciter commutator. The alternator itself is of normal construction except that no sliprings or brushgear are fitted. Its rotor shaft is extended beyond the non-driving end bearing to carry the exciter armature, this portion of the shaft being hollow to accommodate the connections between the alternator rotor winding and the rectifiers.

Rectifiers mounted on the outboard end of the exciter hub have their axes normal to the axis of the shaft, thus ensuring no distortion as a result of centrifugal forces. Automatic voltage control is provided by a static regulator of the magnetic amplifier type, feeding the exciter field winding.

An internal arrangement drawing gives details of a vertical planetary-type speed-reduction gear, four of which are being supplied for the motor-driven circulating-water pump sets at the C.E.G.B. Blyth "B" Power Station. The equipment is designed for transmitting 3250 h.p. at 988–185·2 r.p.m., and the gear case is designed to support the dead weight of the motor, in this instance approximately 22 tons. Its input and output

shafts are flexibly coupled to the motor and pump shaft, respectively. This is believed to be the first epicyclic gear unit for a vertical circulating-water pump application in a United Kingdom power station, and the use of this type of gearing is likely to increase in the future because the cost of direct-drive motors tends to become prohibitive for large-capacity, slow-running pumping units.

The pump to be driven through the gear has 78in nominal diameter branches, and is designed to pump 147,500 gallons of sea water per minute against a total head from all causes of 59·2ft. The pump runs at 185 r.p.m. and absorbs 3020 h.p. This is the first power station in this country for which the circulating-water pumps will have a volute constructed in concrete and forming part of the pumphouse.

English Electric Company, Ltd.

A British Railways Type-1 diesel-electric locomotive which will form the main exhibit of the English Electric Company, Ltd., has a weight of 72 tons and is powered by an eight-cylinder diesel engine which develops 1000 h.p. It is one of 128 similar locomotives being built for British Railways, for suburban and transfer duties. A sectioned and working model of British Railways Type-4 (2000 h.p.) diesel-electric locomotive is also to be shown.

Representative of the gas turbines made by the company will be a model of the EM27P industrial unit, one of which is shown in Fig. 3. This turbine is designed to operate on distillate fuels, natural gas or crude oil. It is of compact, open-cycle, two-shaft design and is readily transportable and easy to install for a variety of industrial, traction and marine applications.

The marine exhibits of the company's switchgear division will include a working display of a simulated marine a.c. distribution scheme in a large passenger ship operated from a local control point. This model is designed to demonstrate the procedure of starting alternators, synchronising, loading, and dealing with fault currents : the tripping out of non-essential circuits on a timed three-stage basis and a complete shut down with an emergency set providing power for such essentials as navigation and other important lights, radio room, steering gear, &c.

A new range of rotary electric actuators has been introduced for the automatic control of valves in power stations, oil refineries, chemical plants, nuclear projects,

Fig. 4—Rotary electric actuator attached to a gate valve—English Electric

and installations where valve control is needed. These actuators, one of which is shown on a gate valve in Fig. 4, can be supplied as individual components or as part of a complete control system. Visual indication of the open, shut or intermediate position of the valve is given on the actuator, with provision for remote indication and control.

The three actuators available provide torque outputs from 80 to 800 lb ft, and the required rotary motion is given by a 400V–440V, three-phase, 50 c/s squirrel-cage induction motor, which drives the output nut via an oil-immersed worm reduction gear box. The motors, designed with high torque and low inertia characteristics, can also be wound for any other a.c. polyphase or d.c. supply. A " hammer blow " effect for moving a " sticking " valve is given by an in-built lost motion mechanism, which allows the motor to run up to full speed before transmitting torque to the valve spindle.

A working display of the linear electric actuators made by the firm will be carrying out a typical opening and closing movement under remote control. These actuators are capable of a thrust of 3000 lb to a stroke of 8·5in in thirty-five seconds.

Westinghouse Brake and Signal Company, Ltd.

In order to demonstrate its remote control systems applied to ship propulsion the Westinghouse Brake and Signal Company, Ltd., Kingswood, Bristol, will have on the stand a dummy ship's bridge on which can be seen two forms of telegraph for operating a controlled propeller, an engine and a gearbox assembly. Where the control is applied to a marine diesel engine coupled to an ahead/neutral/astern gearbox, the ship's master is provided on the bridge with a single handle control for engine speed and propeller direction. The other control system demonstrated shows how the master can control engine speed and propeller pitch from a single control telegraph of conventional design.

Numerous safety devices and interlocks to protect the propulsion machinery from inadvertent misuse are incorporated in the ship control systems. For instance the master can put his control lever rapidly from ahead to astern and vice versa without allowing for the necessary time delays to avoid undue stresses on the engines and transmissions ; these delays are automatically provided for in the control system.

Bryce Berger, Ltd.

In addition to fuel injection equipment Bryce Berger, Ltd., Hucclecote, Gloucester, will be exhibiting the " Speedlock " governor which was developed for engines from 500 h.p. to 5000 h.p. This unit is designed to give good governing performance combined with simple construction and a flexible layout on the engine. Basically, it consists of an engine-driven pump delivering hydraulic fluid to a nozzle, the jet of which impinges against a spring-biased scoop. The force exerted by this jet is proportional to engine speed and the consequent movement of the scoop is transmitted to a servo system which in turn is linked to an output shaft connected to the engine control gear. The engine-driven pump, which provides both the speed sensing and the servo oil pressure, can be mounted in any convenient position on the engine.

We are informed that the " Speedlock 36 " has been successfully applied to the Sulzer engines in a fleet of vessels engaged in the paper pulp trade. A particular requirement of these vessels is to be able to steam steadily at reduced speed for long periods through the St. Lawrence Seaway. The ability of the " Speedlock " to control engine revolutions precisely at any point in the speed range enables such operations to be carried out smoothly, and relieves the governor driving gear of the heavy wear which is sometimes encountered at low engine speeds.

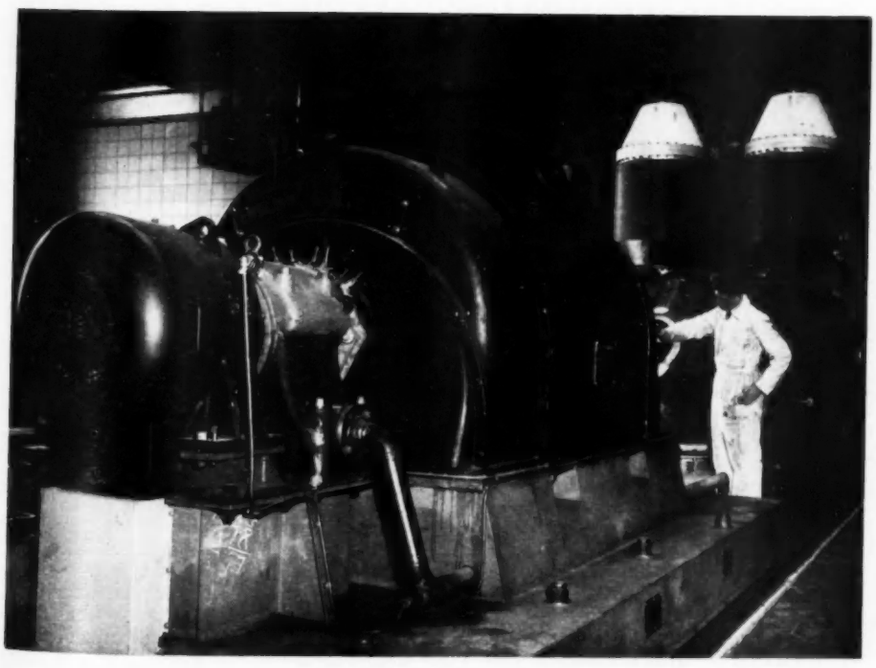


Fig. 3—Industrial gas turbo-alternator set. The non-recuperative turbine drives a 2250kW turbo-alternator through epicyclic reduction gearing—English Electric

Tangyes, Ltd.

The central exhibit of Tangyes, Ltd., Birmingham, will be one of the " Hydraflo " high pressure pumping sets (Fig. 5) which

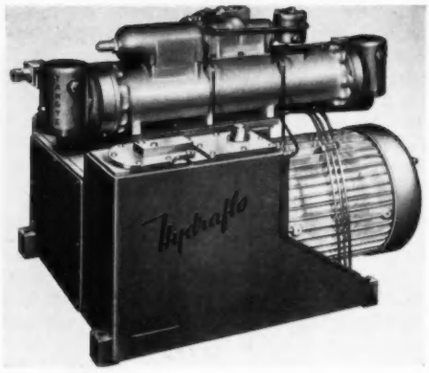


Fig. 5—High-pressure water pump driven by oil hydraulic pressure and providing steplessly variable speeds and output—Tangye

were described in detail in our issue of March 20, 1959. These pumps are made for input powers up to 90 h.p. ; with an output pressure of 9000 lb per square inch a delivery of 10 g.p.m. is given and at the other end of the range 75 g.p.m. is delivered at 1000 lb per square inch. The pumps can be supplied for either a fixed or variable output and the controls for output and pressure can be arranged for manual, automatic or combined manual and automatic operation.

In these pumping sets reciprocation is effected by a high-pressure oil actuated piston set in line with the water pumping cylinder.

Fig. 6—Bench press of 10 tons capacity powered by hydraulic two-speed hand pump—Tangye

The transmission pump, driven by a squirrel-cage motor, draws oil from the reservoir and delivers it, via a sequence valve controlling the direction of flow, to the double-acting driving piston. This piston, directly connected to the pumping pistons, which reciprocate with it at a virtually constant velocity, result in a smooth continuous delivery output characteristic. The standard constant pressure control incorporated is designed to automatically adjust the pump speed, within the limits of its maximum rating, to balance the circuit demands and simultaneously to maintain a virtually constant delivery pressure at the maximum rated value. The power consumption varies in accordance with the delivery output over the entire speed range and eliminates power wastage. By adjusting pre-set controls the rated delivery output and/or pressure can be reduced as necessary to meet changing conditions. When the pump is in circuit the delivery output is maintained until the rated pressure is reached, and the constant pressure control comes into effect to reduce the delivery output sufficiently to maintain the rated pressure in the circuit.

A useful bench press of 10 tons capacity, introduced by Tangyes, Ltd., incorporates the " Hydrapak " two-speed, hydraulic hand pump. In this pump the two speeds are provided by two different size plungers, one plunger providing pressures up to 750 lb per square inch and the other pressures up to 10,000 lb per square inch. The change-over from one pressure to the other is by depression of a push button. One plunger of the pump is situated inside the other to give a compact totally enclosed unit which weighs only 10 lb.

The new press (Fig. 6) has a 2½in diameter ram and a stroke of 5in, the hydraulic piston being 3½in diameter. When the ram is fully restricted there is a clear distance of 11in to the work table which has width of 13in and is 10in deep. Three strokes of the pump lever, when in the low pressure setting, move the ram 1in ; this low pressure setting being suitable for exerting pressures of up to about 2½ tons and being used for rapid advance of the ram towards the work. In the high pressure setting about seventeen strokes of the lever are required for each 1in movement of the ram.

Decca Radar, Ltd.

The radar equipment of Decca Radar, Ltd., Albert Embankment, London, S.E.11, will include the firm's 16in display console incorporating the interscan technique for the rapid measurement of range and bearing. Interscan, a feature of the 16in display console shown in Fig. 7, is a continuously visible line which appears on the P.P.I. originating from a ship's own position. From the variation in length and direction of this line range and bearing information can be obtained in the shortest possible time and with great accuracy on any number of targets and on any type of presentation, relative or true, stabilised or unstabilised. The ability to obtain these measurements rapidly and accurately is a factor of great significance, particularly in congested waters where continuous information of change of range and bearing must be maintained in respect of several ships simultaneously.

The console is also provided with a polaroid daylight viewing hood permitting simultaneous viewing by two operators in normal direct lighting. There is also a built-in true motion ; seven range scales extending from three-quarters to sixty nautical miles ; means of variable differentiation, giving control of picture sharpness to suit physical characteristics of the locality ; and controls grouped according to their function so that they come readily to hand when needed.

A new 10ft slotted waveguide aerial introduced by Decca is stated to give important improvements to radar performance, including longer detection range on all targets ; very low side lobe level ; improved close range performance ; and low top weight and windage. Its beamwidth of 0·75 deg. at half power points results in a sharply focused main beam. The aerial is claimed to provide excellent bearing discrimination particularly against strong echoes

Fig. 7—16in true motion display console incorporating the interscan method of range and bearing measurement—Decca

at close range and the P.P.I. picture displayed is of very high quality. A substantial improvement in target to clutter ratio achieved with this aerial ensures better detection of small targets in the presence of precipitation and sea returns.

G. A. Harvey and Co. (London), Ltd.

A 20-ton jacketted autoclave which will be the principal exhibit of G. A. Harvey and Co. (London), Ltd., London, S.E.7, is one of four being constructed to the order of Howards of Ilford, Ltd. for use in the manufacture of industrial chemicals by a high-pressure hydrogenation process. The autoclave has a 1½in thick stainless clad steel shell and is 6ft inside diameter by 11ft high. It has been made to class-I requirements, being fully stress relieved ; on completion the shell was hydraulically tested to 825 lb per square inch.

A multi-bladed impeller, driven by a 50 h.p., motor mixes the autoclave contents at 120 r.p.m. under a working pressure of 500 lb per square inch and at temperatures up to 200 deg. Cent. A " Flexibox " mechanical seal is fitted at the top of the autoclave where the impeller spindle enters.

Also shown on this stand will be scale models—one of a fractionating column typical of those used in the oil refining industry, and the other of the Rolls-Royce jet engine test plant, for which the company was responsible for the design fabrication and erection of test cells, pressure vessels and ducting.

Stewarts and Lloyds, Ltd.

A resonance bending fatigue machine used in the research and technical development department of Stewarts and Lloyds, Ltd., Corby, will be one of the exhibits on the company's stand. This machine, which is used for investigations into the fatigue strength of tubes and welded joints, will be carrying out tests on a welded-on fin tube made by the Extended Surface Tube Company. Such tubes in service in nuclear boilers can be subject to vibrations set up by the gas flowing over them, and it is necessary to determine the strength of the tubes under these conditions.

The machine is shown in operation in Fig. 8. In it the tube is supported at two points and, by two contra rotating weights attached near one end, vibrations are set up in the tube. The amplitude of vibration increases rapidly when the rotational frequency of the weights is near the natural frequency of the tube. This amplitude can be controlled by slight variation of the speed of the d.c. motor used for driving the weights and it can be read from an amplitude indicator attached to the specimen. The maximum stress in the testpiece during vibration can also be measured by electric resistance strain gauges.

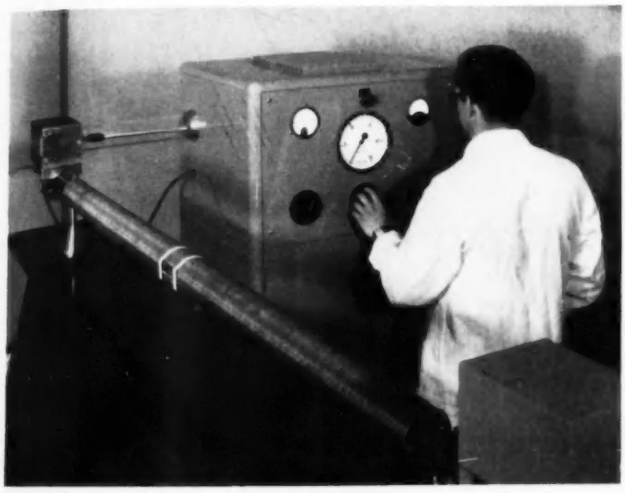


Fig. 8—Resonance bending fatigue testing machine in operation — Stewarts and Lloyds

In a fatigue test the specimen is vibrated at a fixed amplitude or stress and the test is continued until a fatigue crack develops. A simple means has been devised to detect the occurrence of failure. The tube is filled with air at about 15 lb per square inch and the pressure is indicated by a gauge carrying a pressure-operated switch. When the specimen cracks pressure is released and the switch is operated to shut down the driving motor and stop a counter. By running a series of tests at different stresses, a relationship between stress and number of cycles to failure can be obtained, and from this information the fatigue strength of the tube for a specific number of cycles can be determined.

Tubular products also shown will include a short length of 12in nominal bore seamless steel pipe typical of that supplied for high-pressure mains for gas grids. The ends of the pipe are prepared for welding and it has internal protection of red lead with an external sheathing of woven glass. An 8in bore seamless steel pipe inside a 16in outside diameter pipe is typical of that supplied by the company for the disposal of atomic wastes in the effluent lines of the Winfrith Atomic Energy Establishment.

Hamworthy Engineering, Ltd.

An air-cooled compressor of clean compact design known as the " Hestair " has been added to the range of reciprocating machines made by Hamworthy Engineering, Ltd., Poole, Dorset. This single-stage, single-acting machine is designed for free air deliveries from 10 to 25 cubic feet per minute at pressures from 150 lb to 350 lb per square inch. It is made in two sizes with cylinder bores of 3½in and 4in but, apart from the cylinder barrel and piston, all parts of the compressors are interchangeable. The smaller capacity machine has a cast iron piston and that of the larger machine is of aluminium alloy.

The lead-bronze bushes fitted throughout the compressor are splash lubricated. A concentric suction and delivery spring-loaded plate valve is located between the cylinder barrel and cylinder head and the standard fittings include an air inlet filter, relief valve and screw-down hand unloader. A fan, belt-driven from the crankshaft, delivers cooling air through a sheet metal shroud on to the cylinder and head, which are extensively finned to provide the maximum cooling effect.

This company's recently introduced " Dolphin " vertical centrifugal pump, one of which is shown in Fig. 10, is available in capacities from 60 to 2000 gallons per minute with heads up to 300ft. These pumps, originally developed for marine duties, have been re-designed to cover a wide range of other applications. The range of capacities is covered by only three pump frame sizes, and by interchanging of impellers and diffusers the pumps can be built to give any desired operating conditions.

The main casings of the pumps have two diametrically opposite motor flanges to give a choice of connection, and enabling the single discharge to be brought to the desired position. The motor support pedestal on top of the casing can be turned to any one of four positions so that the pump can be arranged to give the best possible degree of accessibility in restricted spaces.The impeller is supported by a short, heavy section shaft running in a single bearing which may be either grease or water lubricated and the bearing and shaft can be supplied in special corrosion resistant materials to suit the pumping medium. A short coupling spacer fitted between the motor coupling and shaft facilitates dismantling, and to take out the complete impeller assembly it is only necessary to remove the coupling screws, take out the spacer, remove screws from top cover and withdraw the rotating element complete with top cover bearing and gland from the main casing. Suction and pressure gauges are fitted as standard equipment and self-priming or non self-priming units can be supplied as required.

One of the three sizes of these pumps being exhibited is illustrated in Fig. 10.

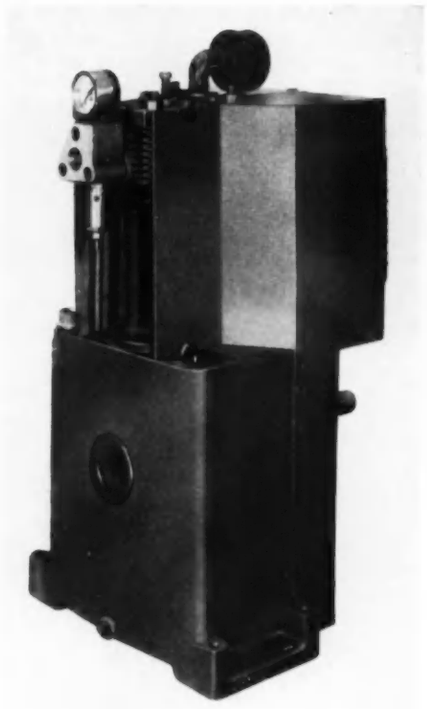


Fig. 9—Single-stage, air-cooled compressor with free air deliveries up to 25 c.f.m. and 350 lb per square inch—Hamworthy

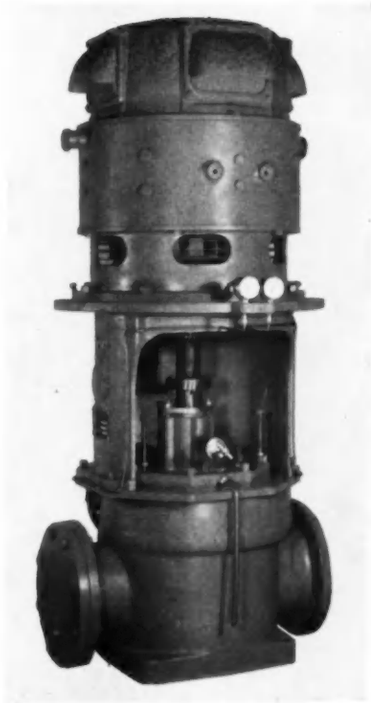


Fig. 10—Vertical centrifugal pump available in capacities of 60 to 2000 g.p.m. with heads up to 300ft—Hamworthy

Lockheed Precision Products, Ltd.

A series of displays illustrating applications of industrial hydraulic equipment are to be accompanied by simplified diagrams of the hydraulic system on the stand of Lockheed Precision Products, Ltd., Speke, Liverpool. This display will include typical control and relief valves, jacks, hydraulic motors, hoses, couplings and other products of the company. Amongst the marine applications of the equipment displayed are the hydraulically operated weather deck hatches of M.V. " Turakina " to be seen in Fig. 11. The rapid operation of such hatches enables them to be quickly dropped to protect, for example, a perishable cargo in the event of a sudden storm when loading or unloading. A small two-way lever used to operate each hinged half of the cover is enclosed in a cupboard on the side of the hatch.

The four hatches are powered in pairs from two power packs installed in the ship's engine-room. These power packs, have an isolating valve in the main power line so that by operating a change-over valve each pack can operate the hatches of its opposite number should it have to shut down for any reason. Each motor and pump is double ended and draws fluid from a common 50-gallon supply tank through micronic filters. At one end of each unit is a large seven cylinder pump with an output of 3·1 gallons per minute and at the opposite end is a smaller seven-cylinder pump with an output of 1·1 gallons per minute. Under working conditions the output of both pumps is passed to the control valve. Depression of the control valve lever passes pressure to the full area of a pair of cylinders provided for each hinged section of the hatch cover, so extending their rams to raise the cover. Lifting the lever passes pressure to the annular ends of the cylinders to lower the covers. Independent control of the speed for raising and lowering is arranged for each movement.

Under non-working conditions fluid delivered by the smaller pump blows off through a relief valve, set to operate at 2800 lb per square inch and passes to drain via a restrictor valve. The back pressure created by this restrictor valve is sufficient to move across the spool of an hydraulically operated control valve to connect the line leading from the pilot port of a pilot-operated relief valve to drain. The plunger of the relief valve rises, permitting the output of the larger pump to pass through its body to drain. As soon as the operation begins, the smaller pump ceases blowing off, thus relieving pressure on the spool of the hydraulically operated control valve which is spring returned and no longer acts as pilot to the pilot-operated relief valve. The output of both pumps is thus immediately available for operation.

Although somewhat complex the effect of this unloading system is to keep the system pressurised at 2800 lb per square inch under non-working conditions by the output of the smaller pump (at the same time allowing the larger pump to idle) so that positive and instantaneous operation is available as and when required.

Another example of the application of Lockheed hydraulic equipment for marine purposes in on three ferries built by Whites Shipyard (Southampton), Ltd., to the designs of the British Transport Commision for service between Tilbury and Gravesend. Each of these ferries has six folding passenger gangways which are hydraulically operated from a control position on the bridge. These gangways were specially designed by MacGregor's and Lockheed Precision Products, and are believed to be the first gangways of their type to be installed on any vessel. The individual gangways are each operated from control boxes on the bridge, each box containing three control valves, one to each gangway. Movement of a control valve lever in an upward direction pressurises the hydraulic line to the full area end of a 4in diameter gangway operating cylinder which extends and raises the gangway. As a gangway nears its fully raised position it knocks up a securing claw, which would hold it should hydraulic pressure fail ; normally, a gangway is held in position by its cylinder and clear of the claw.

Movement of the control lever in the opposite direction delivers fluid to the pressure port of a hydraulically operated control valve and also to its operating end. The valve spool, an extension of which is attached to the gangway securing claw, is thus moved across by the pressure, raising the claw and only then permitting pressure to pass to the differential area end of the operating cylinder to lower the gangway. The spool of the control valve is spring returned to the original position so that when the gangway is being raised the claw is in the securing position. The speeds of lowering and of raising the gangways are controlled independently for each direction by the settings of a double restrictor valve fitted in the hydraulic line to the full area end of the operating cylinder.

Power for the hydraulic system is provided by a motor-driven, seven-cylinder pump which draws fluid from a 20-gallon supply tank via a suction filter and delivers it to two hydraulic accumulators. These accumulators are connected to auxiliary compression bottles to increase their capacity within a chosen pressure range.

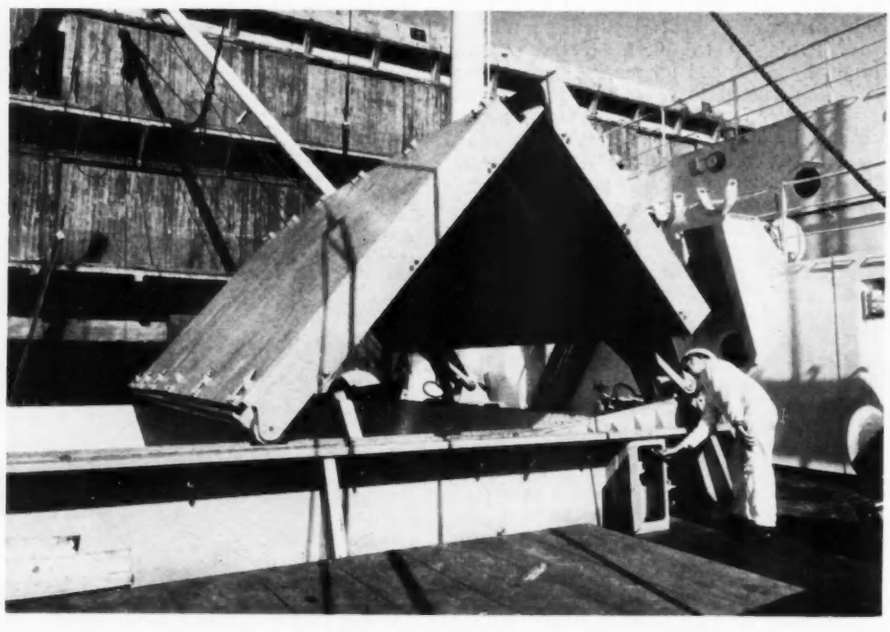


Fig. 11—Hydraulic weatherdeck hatch covers installed on the M.V. " Turakina "—Lockheed

Crane, Ltd.

Amongst the valves and pipe fittings of Crane, Ltd., 15-16, Red Lion Court, Fleet Street, London, E.C.4, there is to be seen a 16in carbon steel valve fitted with the firm's flexible wedge disc. This valve is motorised for electrical control from a remote position and a " Rotork " actuator is used. The valve shown is designed for a 600 lb per square inch system and a typical installation illustrated in Fig. 12 works at 535 lb per square inch up to 1030 deg. Fah.

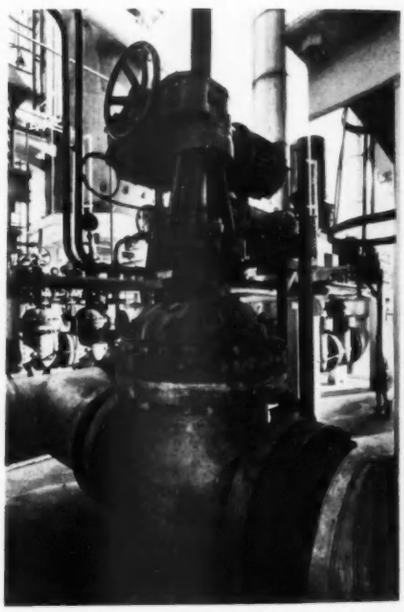


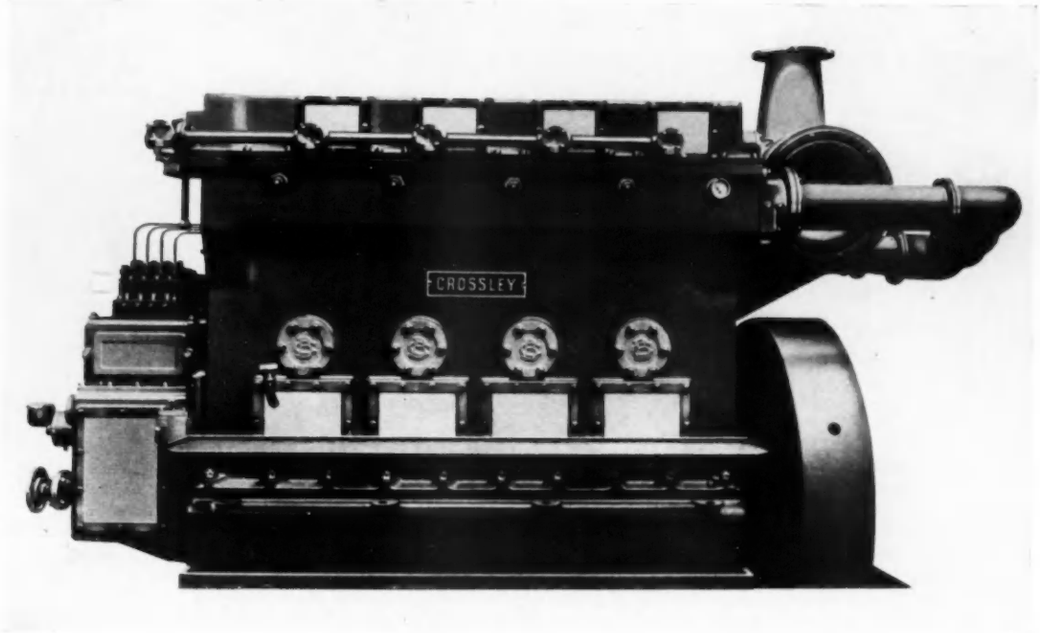
Fig. 12—Large flexible-gate cast steel valve with motorised control—Crane

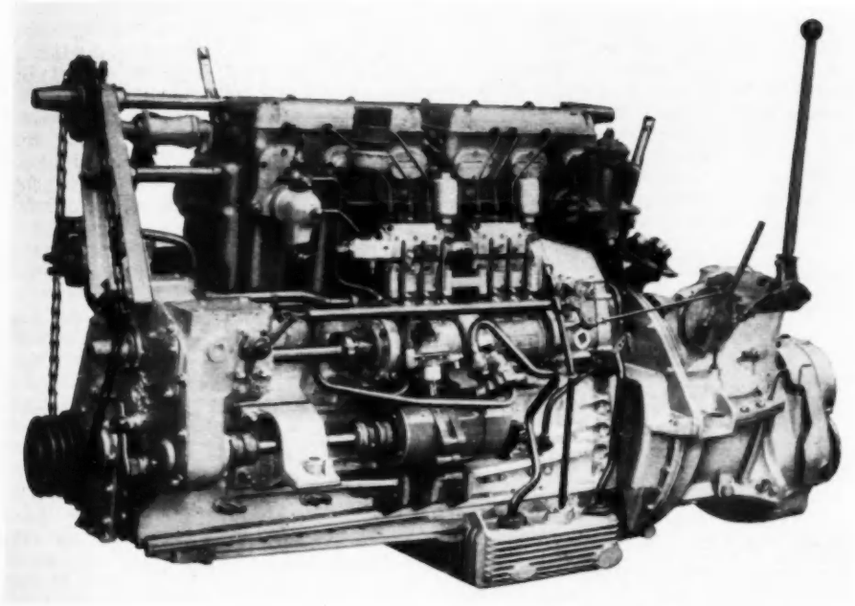
The flexible wedge discs fitted in these valves consist of two seating faces connected by a small diameter central hub. This hub is sufficiently strong to give full support to the two opposed flange-like seating faces and at the same time permit a certain degree of flexibility between the two halves of the wedge assembly. The flexibility imparted by this design prevents a disc sticking in the closed position and reduces the amount of torque required for seating and unseating. This design of valve is available in sizes between 2in and 4in and for most services up to 1100 deg. Fah. The discs can be supplied in various alloys including 13 per cent chromium with seatings of nickel alloy and with " Stellite " hard facings. One of the valves to be shown at Olympia has a chromium alloy trim with " Fluon " inserts in the body seat rings. This design of valve is intended for use in corrosive chemical lines where a very tight shut-off is required.

Oil Engines

The E.P.Q. Crossley engine RIGHT is a four-cylinder exhaust turbo-charged unit having a bore of 10·25in by 12in stroke developing 360 b.h.p. at 500 r.p.m. The engine is available with three to eight cylinders covering powers ranging from 270 to 1040 b.h.p. at 500 to 750 r.p.m.

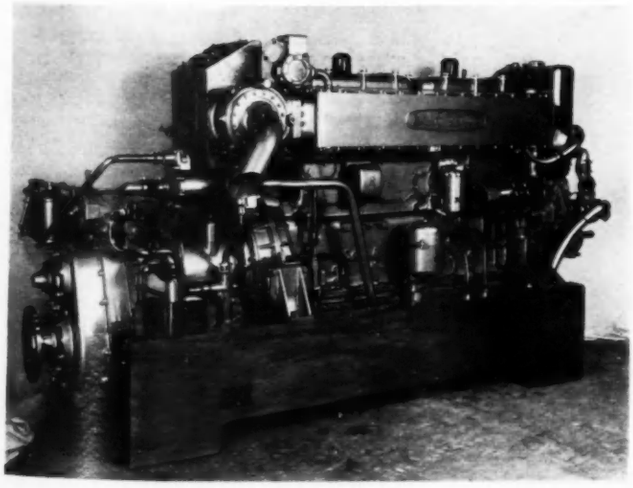
BELOW is shown a Mark 6LX Gardner marine diesel engine which has six cylinders having a bore of 4¾in by 6in stroke and a power rating of 110 b.h.p. at 1300 r.p.m. for heavy duty. The engine drives through a 3 to 1 reduction gear and is equipped with a No. 2 U.C. reverse gear.

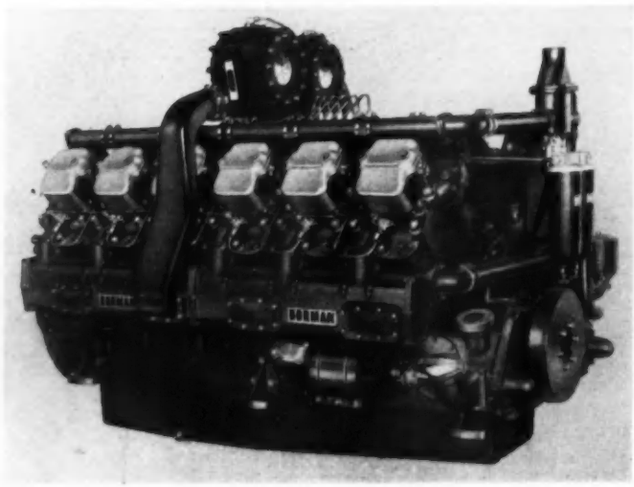




The Ajax Argonaut BELOW LEFT is a six-cylinder, four-stroke unit which is based on the Leyland UE902 direct-injection engine and has a bore and stroke of 5½in by 6½in. A Simms water-cooled Eberspacher turbo-supercharger is fitted and the power output is 207 b.h.p. at 1600 r.p.m. on a continuous twenty-four hour rating, while the drive is through a hydraulically controlled MRF16 Self-Changing Gears step down reduction gearbox. Maximum installation angle is 1 in 7. The cylinder block and crankcase form a monobloc iron casting and pre-finished cast iron wet liners are fitted.

BELOW RIGHT is the Dorman 12 Q.A.T. engine which is a four-stroke, water-cooled, turbo-charged engine having twelve cylinders arranged in two banks at an included angle of 90 deg. The bore and stroke are 6½in by 6½in and the engine develops 325 to 685 b.h.p. over the speed range of 800 to 1800 r.p.m. on one hour rating. The dry weight is about 7500 lb. The crankcase and cylinder unit is a rigid cast iron structure; separate cylinder-heads are fitted and chrome hardened detachable wet liners. Aluminium alloy pistons are fitted, with side by side connecting-rods and an alloy steel crankshaft is carried in thin wall steel strip copper lead lined bearings.





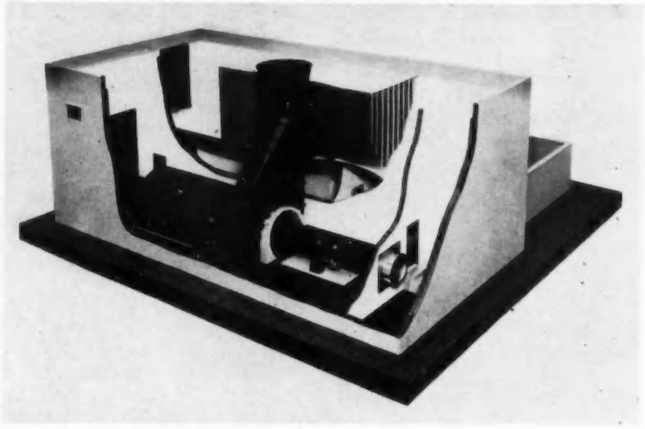


Fig. 13—Model of 15MW generator set driven by an "Olympus" gas turbine for Hams Hall power station —Bristol Siddeley

Bristol Siddeley Engines, Ltd.

A development of particular interest to be seen in model form upon the stand of Bristol Siddeley Engines, Ltd., Filton, Bristol, will be a transportable 3MW turbo-generator set. This " packaged " equipment is a transportable version of 3MW sets which have been designed for service in unattended power stations and supplied to the South Western Electricity Board for installation at Princetown and Lynton in Devonshire. In this compact, self-contained, power pack, a " Proteus " gas turbine is coupled to an alternator supplied by the Electric Construction Company, Ltd.

The pack can be mounted on a standard road transporter or railway flat car and be put into service on any part of the road or rail system without off-loading or jacking. Its small size and light weight make it easily transportable by sea or air and slinging points are built-in to obviate the need for any special gear. A rigid frame construction does away with the need for foundation work if the set is to be used on a fixed or semi-permanent site. The air intake and exhaust systems are silenced to a noise level acceptable for residential areas. Typically, the mobile set would consist of generator pack (44,400 lb) and control pack (12,900 lb), the latter being necessary only when control equipment is not available on the site. The " Proteus " gas turbine has an output shaft speed of 1500 r.p.m. to 1800 r.p.m. and the 3·75MVA, three-phase, alternator is designed for a voltage of 11kV.

Another model on the stand (Fig. 13) will show the firm's 15MW turbo-generator being supplied to the Central Electricity Generating Board for installation at Hams Hall Power Station. This set is driven by a modified version of the " Olympus " turbojet engine developing 21,200 s.h.p., and the alternator has a power rating of 25,000 kVA at 0·8 power factor with a rated voltage of 11,kV. The makers state that for less than half the cost of steam plant, this turbo-generator provides the answer to peak-loading problems, supplies standby power for emergency, cuts maintenance costs and ensures that plant is used at economic load factors. Quick starting and low maintenance are two factors which emphasise its suitability for automatic operation in remote-controlled unmanned stations or bulk supply points. The " Olympus " turbo-generator is also being developed to use natural gas, with a heat rate value of 14,050 B.Th.U. per kilowatt hour. The " Olympus " consists of a five-stage low-pressure axial compressor and a seven-stage high-pressure compressor, each driven independently by a single-stage turbine through co-axial shafts. The two-stage turbine is, as in the case of the " Proteus," driven by the exhaust gases.

Examples of the range of Maybach engines now made under licence by Bristol Siddeley will also be shown on the stand. These lightweight, high-speed, engines cover a power range of from 360 to 3600 b.h.p. Varying from four and six-cylinder in-line, to eight-, twelve- and sixteen-cylinder vee configuration, this MD range of engines is based on a common bore and stroke and 70 per cent of the components are interchangeable. The engines are exhaust-turbo-pressure-charged and are available with or without intercooling. They have a forged, one-piece disc-webbed crankshaft carried on roller bearings in a tunnel type steel crankcase. The use of this disc-webbed crankshaft reduces engine length by using large diameter discs instead of the crankwebs and main journals of conventional designs. Pressure-oil.cooled pistons with detachable steel crowns give efficient heat dissipation and reduce cylinder liner and gas ring wear. The individual and interchangeable cylinder heads have a central pre-combustion chamber and the small cooled valves have automatic clearance adjustment. Each cylinder is fitted with " L'Orange " injectors which combine the pump and injector nozzle in a single unit operating at low pressure, resulting in the elimination of high pressure fuel piping.

In Fig. 14, there can be seen a four-cylinder 394 h.p. engine for use in trawlers in which

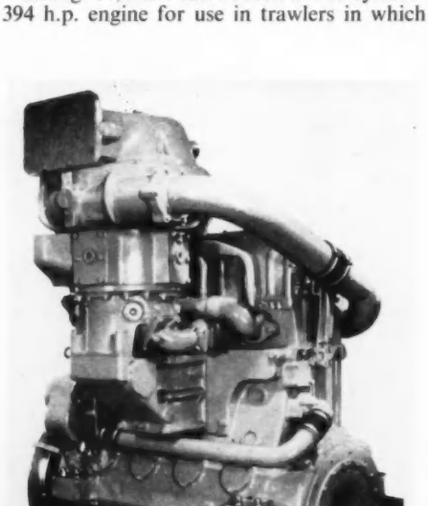


Fig. 14—Four-cylinder 394 h.p. engine for trawlers—Bristol Siddeley

two of the engines are coupled to a single controllable pitch propeller through a twin-input, single output reduction gearbox. A drive from this gearbox is also taken to the winch generator.

Ball screws and splines are made for many applications and are now produced by the firm in a range of sizes from 6in to 30ft shaft lengths. Units of this design are operating under loads of up to 160,000 lb, and are made to a load accuracy of 0·00002in per foot. These screws can operate efficiently in temperatures from −55 deg. Cent. to over 450 deg. Cent. The ball screw shaft and nut are machined with specially contoured spiral grooves along which a recirculating stream of precision ground balls roll in close contact to take the load with a minimum of friction or wear. The range includes the pre-loaded type, used to eliminate backlash where small degrees of movement are required in conditions of no load.

William Doxford & Sons (Engineers) Ltd.

William Doxford and Sons (Engineers), Ltd., will display models and photographs of recent ships, including heavy lift vessels equipped with gear to lift up to 180 tons. Also on view will be a $^{1}/_{10}$ scale working model of the new Mark 67.P.T.6 oil engine which the company recently introduced and which is fitted with three exhaust gas turbo-chargers. On page 581 we reproduce a photograph of the actual engine which is the first of the " P " range of engines to be built, and was installed in the 20,000 tons deadweight oil tanker " Montana " which is now in service. It is a six-cylinder unit having a bore of 670mm and opposed pistons of 720mm stroke and 1380mm stroke for the upper and lower pistons respectively. The service power rating is 10,000 b.h.p. at 120 r.p.m., and the engine has a length of 45ft 6in, a height of 31ft 2in, a width of 12ft 2in, and a weight of 375 tons which is equivalent to 26·7 b.h.p per ton. The engine has a stress-relieved welded bedplate, consisting of two longitudinal box girders joined by double transverse girders, and a two-piece crankshaft joined by a rigid coupling and carried in pressure lubricated steel shell white-metal-lined thin wall bearings. Both the centre and side connecting rods are palm ended and both have white-metal-lined top and bottom bearings. Also on the stand there will be a full-scale sectioned working model of a Doxford twin spindle fuel injection timing valve, and a half-size model of a 670mm bore three-piece cylinder liner with pistons and part entablature. This model is sectioned to show, the upper and lower sections of the liner, with the combustion chamber fitted between, cooling water jackets and the arrangement for circulation of coolant to the pistons.

Crossley Brothers, Ltd.

Crossley Brothers, Ltd., in addition to the four-cylinder, E.P.Q., four-cycle, turbo-charged diesel engine, illustrated in our page of engines, will show a Mark H.R.P.8, eight-cylinder in-line, two-cycle direct reversing, turbo-charged scavenge pump diesel engine. The engine, which is shown fitted with the Crossley system of servo control for operating the reversing and speed control of the engine from the bridge telegraph, has a bore and stroke of 10·5in by 13·5in and is capable of developing 900 to 1600 b.h.p. over the speed range of 300 to 600 r.p.m. The exhaust-gas-driven turbo-charger is arranged in series with the engine-driven scavenge pump so that the engine can

Fig. 15—Crossley/Standard diesel marine engine coupled to a 2 : 1 reverse reduction gearbox developing 48 b.h.p. at 3000 r.p.m. —Crossley Brothers

operate at reduced output when the turbo-charging equipment is not in operation. Also incorporated in the engine is " Exhaust Pulse Pressure Charging." Both the crankcase and cylinder block are monobloc castings and the chromium-plated liners are detachable, while the cylinder heads are water-cooled The crankshaft has a high natural frequency and is carried in white-metal-lined steel-backed bearings. Oil-cooled pistons having four pressure and two scraper rings are used. Fuel pumps, which operate on the port control principle, are driven through spiral gearing from the crankshaft. Pressure lubrication is employed, the system including a cooler, and the engine is suitable for closed or open water-cooling systems using either centrifugal or plunger pumps.

Smaller engines on the stand will be representative of the Crossley-Standard range including a unit (illustrated in Fig. 15), with a 2 : 1 reverse reduction gearbox and developing 48 b.h.p. at 3000 r.p.m., a power pack unit with a clutch power take off and a 30kW diesel generator set. The power unit has four cylinders of 3·31in bore by 4in stroke and a compression ratio of 20. High-duty cast iron is used for the cylinder block which is integral with the crankcase and has slip fit dry liners. Pistons are of aluminium alloy, connecting rods are of manganese molybdenum steel and have indium flashed, steel-backed copper-lead lined big end bearings, similar bearings carrying the three bearing crankshaft. A plunger distributor fuel pump is mounted and lubrication is by a high-pressure gear-driven pump. Cooling is by a closed fresh water circuit incorporating a sea water circulated heat exchanger.

W. H. Dorman & Co. Ltd.

Many engines, including the 12 Q.A.T. unit illustrated among the engines on page 587 will be shown by the company. There will be a Mark 6 Q.A.M. six-cylinder, in-line, marine, normally aspirated, direct injection diesel engine of 6¼in bore by 6·5in stroke and developing from 100 to 230 s.h.p. over the speed range of 800 to 1800 r.p.m., the compression pressure being 480 lb to 500 lb per square inch, and the maximum firing pressure being 1050 lb per square inch. The crankcase and cylinder unit, housing chrome-hardened wet liners, is a rigid cast iron structure and there are two iron cylinder heads, each covering three cylinders. Aluminium alloy pistons are fitted, also connecting-rods of " H " section steel stampings and an alloy steel crankshaft carried in steel strip copper-lined bearings. Fuel injection equipment includes a Simms fuel pump, a diaphragm lift pump and multi-hole nozzles. Pressure lubrication is employed and cooling is by a closed circuit fresh-water system and sea-water circulated heat exchangers.

Another six-cylinder engine to be exhibited is the 6KWD.M., which has a horse-power range of 80 to 160 over the speed range 800 to 1800 r.p.m. and a bore and stroke of 140mm by 160mm. This engine has a rigid cast iron crankcase, a detachable monobloc cylinder housing, six chrome hardened wet liners and a crankshaft supported in seven pre-finished steel-backed, copper-lead lined bearings. A C.A.V. multi-cylinder base-mounted fuel injection pump is employed and a plunger lift pump. There is one inlet valve and one exhaust valve, each push-rod operated, per cylinder.

In the lower power range is the normally aspirated, four-stroke, water-cooled, direct-injection 4 LBM engine having four cylinders of 125mm by 130mm stroke, a compression ratio of 15·5 to 1 with a full load output of 34·5 to 75 s.h.p. at 800 to 1800 r.p.m., and a maximum torque of 234 lb feet at 1200 r.p.m. C.A.V. fuel injection pump with plunger lift pump and injectors are fitted and cooling is by a thermostatically controlled closed fresh water system.

Burmeister and Wain

Burmeister and Wain will show two models of the range of diesel engines built by the company, one of which represents a Mark 74-VTBF 160 engine and the other, a Mark 84-VT2BF-180 unit. The latter illustrates the latest development in diesel engine production being of large bore and conservatively rated to develop 2100 b.h.p. per cylinder. The model, illustrated in Fig. 16 below, is of a twelve-cylinder turbo-charged, single-acting, two-stroke crosshead engine having a bore of 840 mm by a stroke of 1800 mm. It has a service rating of 25,200 b.h.p. at 110 r.p.m., a mean indicated pressure of 9·5 kg per square centimetre, and an overload rating of 27,700 b.h.p., without time limit, and 30,200 b.h.p. for short periods. The mechanical efficiency of this design of engine is claimed to be about 90 per cent. The first engine of this design, a ten-cylinder unit, recently completed shop trials and was installed in an oil tanker, and at full load had a fuel consumption of 158 grammes per brake horse-power per hour. Largely of cast iron construction, the engine had a weight of 830 tons which could be reduced to 750 tons for welded construction; the corresponding weights for the twelve-cylinder engine are about 980 and 885 tons respectively. Also on view is a 406-VO Alpha engine and models of a variety of ships indicative of the shipbuilding activities of the company.

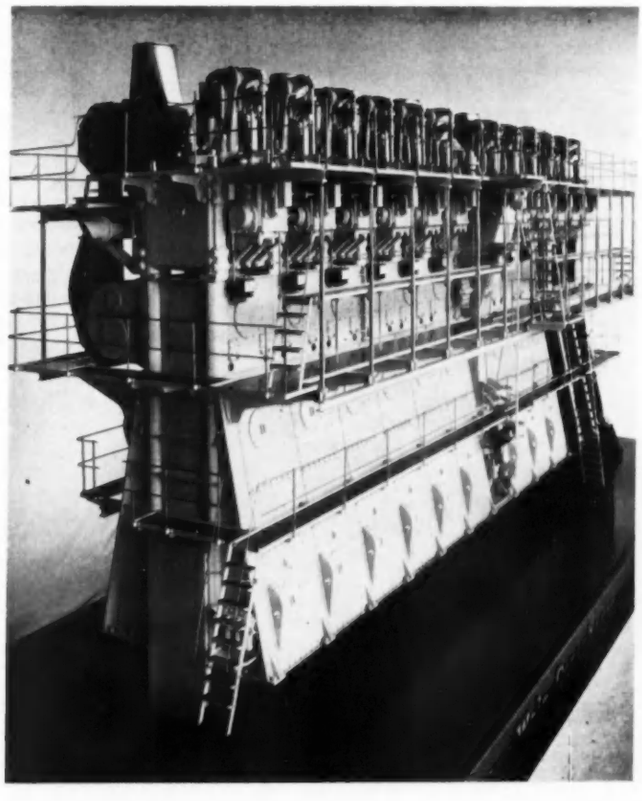


Fig. 16—Model of twelve-cylinder 84-VT2BF-180 engine. This engine has a service rating of 25,200 b.h.p. at 110 r.p.m.— Burmeister and Wain

C.A.V., Ltd.

The representative selection of fuel injectors, turbo-chargers, starters and electrical equipment to be exhibited by C.A.V., Ltd., Action, W.3, includes examples of the firm's electro-mechanical devices for nuclear energy applications. Typical of these devices is the electrically operated eighteen-position rotary selector gas valve which is designed for use in the fission-products detection system of gas-cooled nuclear power plants. This valve can be seen mounted on one of the control head brackets for a gas-cooled nuclear reactor in the photograph we reproduce in Fig. 17. It is designed to give early warning of radio active contamination

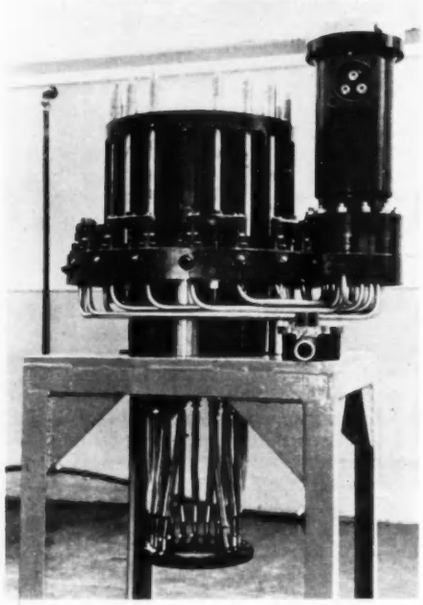


Fig. 17—Eighteen-position rotary selector gas valve for use in a fission products detection system for a gas-cooled nuclear power plant—C.A.V.

of the CO_2 gas circuit to the heat exchanger of an installation, which would result from fracture of a fuel can in the reactor core. The eighteen positions of the valve are selected automatically in sequence by an electrically driven indexing mechanism.

The engine starter equipment to be shown includes the gas turbine starter for machines up to about 3000 h.p. illustrated in Fig. 18. With this equipment starting is effected in timed stages under the control of an automatic switch unit. This switch, supplied separately, also controls the operation of the turbine ignition system, fuel valve, and the gas valve through which propane gas is delivered to the combustion chamber to assist starting. A ratchet-toothed clutch effects engagement between the starter and turbine and at the commencement of the starting sequence the clutch member on the starter drive shaft is moved forwards by a solenoid into mesh with a complimentary member on the turbine shaft. Contact breakers also fitted on the starter are used to provide the interrupted supply for the gas turbine ignitors.

In showing 8in and 14in diameter a.c. generators for battery charging and lighting systems the firm points out that the alernating current generator has certain advantages compared with the direct current machine, particularly where the prime mover operates at low speeds for long periods. This design of generator is capable of generating the whole or a substantial part of its output over a wide speed range and can therefore maintain a satisfactory charge in the battery even when the engine is idling. It is of lighter and simpler construction than a direct current machine of comparable output and has no commutation problems.

A 7in diameter a.c. generator in this range, illustrated in Fig. 19, has built-in diodes

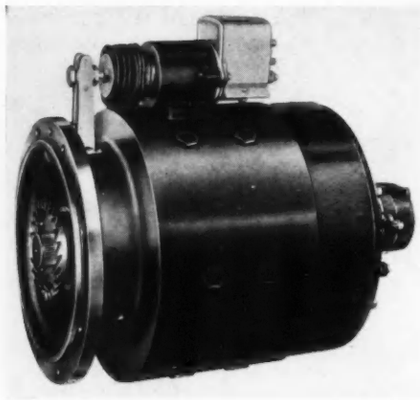


Fig. 18—Starter for gas turbines of up to 3000 h.p. —C.A.V.

and is provided with a fully transistorised regulator. In this regulator a medium power transistor is connected in the generator field circuit in place of conventional vibrating contacts. The transistor is driven "on" and "off" by a low-power transistor which has a Zener diode in its base circuit and the

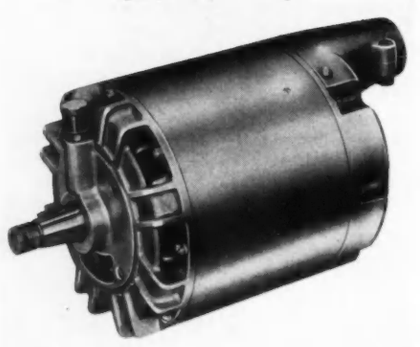


Fig. 19—A.C. generator with built-in rectifier diodes, for battery charging and lighting systems—C.A.V.

switching cycle is initiated by the breakdown of the diode when the output of the generator reaches a predetermined value. The standard of regulation achieved by this arrangement is stated to be very high, and to be, in all respects, superior to that of a conventional vibrating contact regulator. The output voltage is held absolutely steady, and change of voltage with temperature is negligible for all practical purposes. Further, the absence of contacts and moving parts results in greater reliability and reduces the amount of attention required during service.

The "Thermostart" made by this firm is designed to assist the starting of diesel engines at low ambient temperatures. It operates by burning fuel in the inlet manifold, so heating the air drawn into the cylinders. Electrically operated from a switch, it employs the same fuel as the engine, thereby eliminating the disadvantages and supply difficulties arising from the use of a special fuel for the starting aid.

Clayton Dewandre, Ltd.

Some of the applications of the "Clayton-Still" tube in heat exchangers will be shown on the stand of Clayton Dewandre, Ltd., Titanic Works, Lincoln. With this design of tube, a section of which is to be seen in Fig. 20, the extended surface consists of a continuous wire wound into elongated loops which are bonded to the basic tube in a helical formation. As the rate of heat transfer to or from a small-diameter wire is extremely high, the resultant large dissipating surface, aided by air turbulence induced by the formation of the wire, gives a very high coefficient of heat transfer.

Standard tubes as such, are not made in this design but to meet any particular application or requirement a comparatively simple alteration is made in surface ratios, loop width and height, winding density, the gauge of the tube and wire, and the method of bonding. The elements can be supplied with basic tube diameters from $\frac{1}{4}$in to 3in and over-wire diameters of $\frac{3}{8}$in to $4\frac{1}{2}$in in 25ft lengths; in copper, copper alloys, brass, mild steel, stainless steel and other metals. Generally the wire formation is bonded to the base tube by soft soldering or, for higher temperatures, by induction brazing using a selection of copper-silver brazing alloys. A more recent form of bonding developed for iron wire and steel tube is hot-dip galvanising.

Two special kinds of tube have been evolved for the cooling of oils and other hydrocarbon liquids. In both cases the inner surface (as well as the outer, if required) is extended: in one case by the insertion of three small-diameter tubes (generally only used when the liquid contains large flakes of suspended matter), in the other by the bonding-in of a spiral looped wire formation. This latter design of element is now available without a centre rod so that it can be used in applications where the rate of heat exchange and the fluid pressure drop are critical.

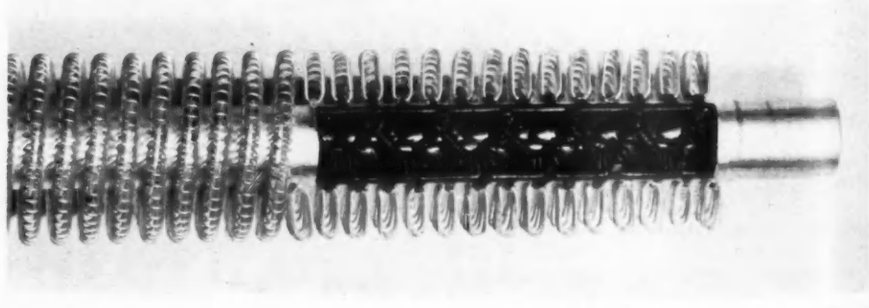


Fig. 20—Heat exchange tube for the cooling of oil and other hydro-carbon liquids. This element has a wire-wound insert bonded to the bore of the tube—Clayton Dewandre

Copes Regulators Ltd.

A variable-orifice desuperheater is the most recent development to be seen with the boiler equipment exhibited by Copes Regulators, Ltd., 9, Southampton Place, London, W.C.1. The construction of this desuperheater is shown in Fig. 21, where it will be noted that a ball, of precise weight, registers over an orifice in the steam main at a point where the steam flows vertically upwards. The ball is the only moving part of the unit and it is lifted off its seating when the pressure of steam below the seating is about 3 lb per square inch higher than that above. By this arrangement, irrespective of the rate of steam flow, a constant pressure drop is always maintained across the seating due to the weight of the ball which must be overcome. The steam velocity at the orifice also remains constant for all rates of flow in the steam main.

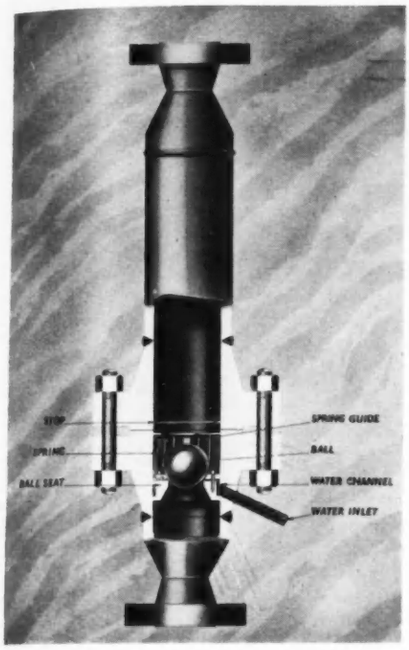


Fig. 21—Variable-orifice desuperheater—Copes

Cooling water at an excess pressure—which can be as low as 30 lb per square inch—enters a trough surrounding the orifice where it meets steam travelling at its highest velocity. This causes extreme turbulence, thus breaking up the water into minute particles which readily vaporise. Since the steam flows upwards, any unvaporised particles remain in suspension until they are absorbed, which means that efficient mixing is achieved irrespective of the rate of flow of the steam.

The maker states that it has been found in practice that this variable orifice desuperheater gives good control from 100 per cent down to 2 per cent full load and holds final steam temperature to within plus or minus 5 deg. Fah of the required setting, even when this is as low as 10 deg. Fah. above saturated temperature. Mixing is so rapid that dry superheated steam at the correct temperature is produced only 20ft downstream of the desuperheaters, with a resultant reduction in time lag between variations in temperature and their correction.

The flow of cooling water is regulated by a conventional diaphragm valve which reacts to air signals transmitted from a temperature controller fitted a short distance downstream of the desuperheater.

W. C. Holmes and Co., Ltd.

The industrial process equipment of W. C. Holmes and Co., Ltd., Turnbridge, Huddersfield, includes the Holmes-Kemp inert gas generator which is designed to produce an inert gas to any desired specification by the controlled combustion of fuel gas or fuel oil. These plants (Fig. 22) can be arranged to produce gas either continuously or intermittently, so that it can be delivered at low pressure direct to a process, or compressed and stored at high pressure for intermittent use. Where necessary dryers can be incorporated to produce a gas having a low dew point or, by further processing, the gas can be delivered in the form of pure nitrogen.

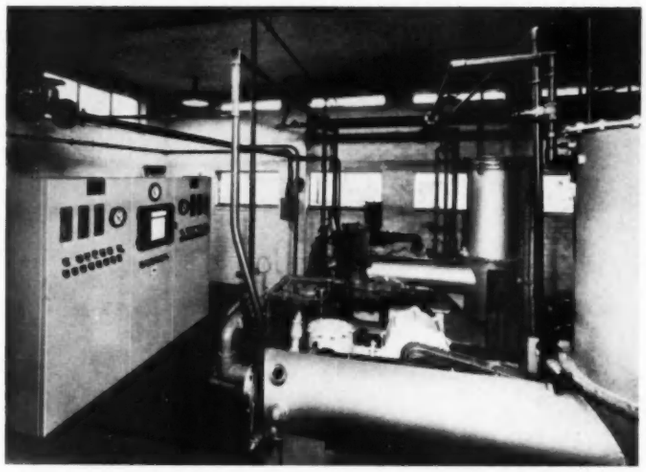


Fig. 22—Twin 2000 c.f.h. inert gas generators—Holmes

The generator employs a Kemp industrial carburettor in which air and gas are premixed to give the required proportions for complete combustion. The carburettor can be easily adjusted to pass any commercial fuel gas and still give the correct air-gas mixture necessary for complete combustion. It is designed to automatically adjust the quantity of air-gas mixture passing forward in accordance with demand and the output of the machine may therefore be cut to as low as 20 per cent of normal output. At this duty the burners are still maintained alight, the turbo-compressor kept cool and the gas produced in excess of requirements vented to atmosphere.

The "Holo-Flite" processor shown in Fig. 23 is a continuous indirect heat exchanger designed to combine maximum heat transfer area with minimum space requirements. Constructed as a screw conveyor with helical, hollow flights through which the heat transfer agent is circulated, the exchanger conveys the material to be heated, cooled or dried at a uniform, predetermined rate. The rotating screws are mounted in a trough and the assembly of screws, trough, bearings and drive gear is the basic unit.

In this processor, the heat transfer agent is isolated from the material being processed and heat is transferred to or from the heat transfer agent by contact with the hollow flights. The intermeshed rotating screws cause the particles of material within the mass to be subjected to continuous movement by the flights and in constantly changing position they make frequent and repeated contact with the heat transfer surfaces. The slow conveying, interfolding and dispersing action of the intermeshed screws prevents dust formation and there is a minimum, if any, abrasion of solid particles.

Liquefied petroleum gases (butane and propane) are finding an increasing number of applications in a variety of industries and the firm will show the arrangement of a typical liquefied petroleum gas plant comprising, storage vessels, vaporiser, associated pipework and control equipment, with possibly a mixing unit in addition. The gases are stored in welded steel vessels at atmospheric temperatures and exert pressures varying from approximately 50 lb to 170 lb per square inch (propane) to 50 lb to 70 lb per square inch (butane). Since their boiling points are approximately −44 deg. Fah. and +22 deg. Fah. respectively, the liquid can be readily converted to vapour.

In the case of propane, the latent heat of vaporisation is usually supplied to the storage vessels by the surrounding atmosphere, but butane, with its higher boiling point, requires the use of a heat exchanger to ensure continuous evaporation. After evaporation, the vapour is normally reduced in pressure by means of governors and fed either directly into a main or into a mixing unit where controlled quantities of air are admitted.

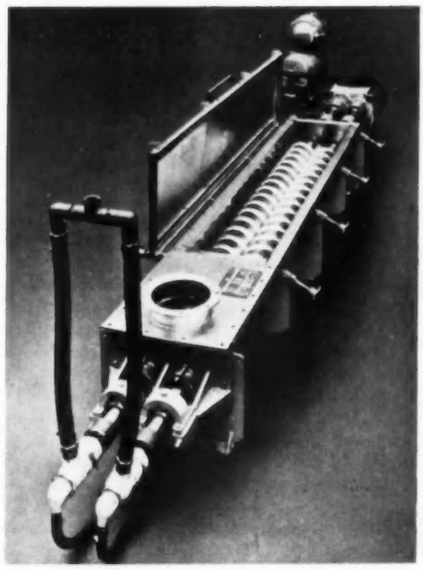


Fig. 23—"Holo-Flite" continuous indirect heat exchanger—Holmes

Robert Harlow and Son, Ltd.

The " Kernon " deadweight pressure relief valve introduced about two years ago by Robert Harlow and Son, Ltd., Stockport, is now made in four models to cover bore sizes of 1in, 2in, 3in and 4in. This valve is intended particularly for use on chemical plant stills and other low-pressure vessels where corrosive conditions make conventional relief valves unsuitable.

The general design of this oil-sealed valve can be seen from the sectional drawing we reproduce (Fig. 24). The spindle is

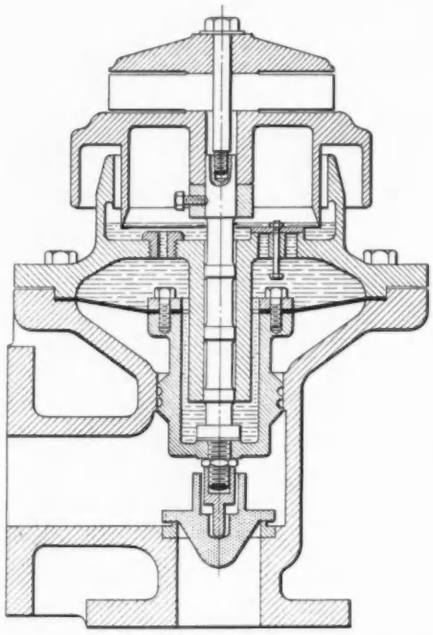


Fig. 24—Deadweight, oil-sealed pressure relief valve—Harlow

supported on long bearings in the main body and at its top end carries the combined cast iron cover and base weight and two separate weights held by a threaded pin. At the lower end the spindle is coupled to a central sliding member which is mounted through a labyrinth seal in the main bore of the body. This sliding member is held by a p.t.f.e. diaphragm in the valve body, the seal forming upper and lower chambers. The upper chamber is filled with oil and in its top there is a four-port non-return valve. In the event of the pressure in the vessel attaining an excessive value the valve is lifted off its seat against the weight imposed on the spindle to allow the valve to blow-off.

In this upwards movement the diaphragm is raised, and the oil in the upper chamber flows freely out through the non-return ports into the reservoir formed on the upper part of the body. After blowing-off—when the main valve is nearly returned to its seat—the oil is drawn back into the chamber above the diaphragm at a controlled rate through a bleed hole, to cushion the final return of the valve to its seat. The diaphragm can act as a bursting disc in the event of a sudden abnormal increase in pressure in the vessel protected by the valve.

A heavy-duty full-way valve made by this firm in 1in to 3in sizes has a spindle which rises through a non-rising handwheel. The design of this valve is such that most of the forces exerted through the handwheel are taken on the strengthened yoke on the cover and therefore do not distort the spindle. The valve can be repacked under pressure, and the design of the spindle and valve body makes it impossible for the clacks to jam when the valve is in use.

Megator Pumps and Compressors, Ltd.

A range of pressure sets for the automatic operation of marine water supply systems developed by Megator Pumps and Compressors, Ltd., 43, Berkeley Square, London, W.1, are supplied as complete equipments, including the pressure tank. They are installed as units, each assembly including wiring and controls and the pipe connections between the pumps and tank.

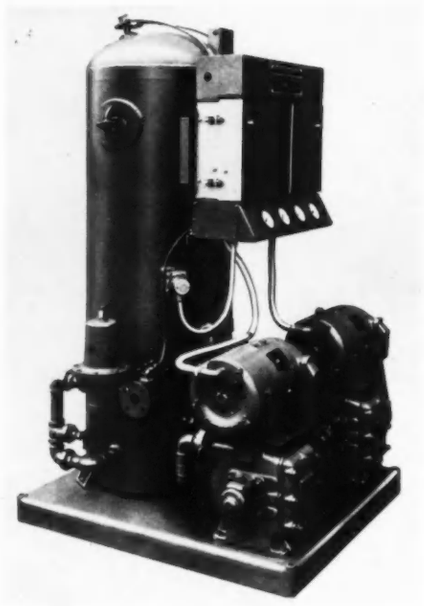


Fig. 25—Pressure set for marine water supplies—Megator Pumps and Compressors

These " Auto-Unit " pressure sets (Fig. 25) for sanitary and fresh-water services, are made in standard sizes with pump capacities up to 25 tons per hour. The pumps operate with a standard cut-out pressure of 80 lb per square inch, a pressure regulator or reducing valve keeping the pressure in the system at the required level. The initial setting of this regulator at the time of installation, or later alteration during service, is the only adjustment required. A simple combination of a pressure switch and a two-way float switch provides automatic control of the pressure and of the air volume in the tank. If the air pressure is below the standard maximum when the water has risen to the cut-out level the tank is automatically connected to a compressed air supply by a solenoid operated valve.

Each set is fitted with two pumps, one of which is a standby, and either of them can be brought into use on automatic or hand control by operation of a rotary selector switch. Suction and delivery isolating non-return valves make the water connections automatically when changing from one pump to another. If an abnormally high peak demand is experienced, beyond the capacity of a single pump, it is possible to arrange for both pumps to be used simultaneously.

Wallsend Slipway and Engineering Company, Ltd.

A packaged automatic oil burner equipment made by the Wallsend Slipway and Engineering Company, Ltd., Wallsend-on-Tyne, is designed to provide fully automatic modulated oil firing for boilers on a wide range of outputs. This equipment (Fig. 26)

Fig. 26—Packaged low-air-pressure automatic oil burning equipment for boilers—Wallsend

incorporates an oil fuel pump, steam and electric heaters, electric torch igniter, oil fuel strainer, primary and secondary air blowers and the necessary controls grouped on a panel.

With this equipment when the start button is depressed a motor which drives the oil pump and fans starts up, current is supplied to the electric heaters and the admission valve to the steam heater opens. The heaters bring the oil circulating round the system to burning temperature whilst the fans deliver air to purge the boiler furnace. Upon the oil in the system attaining the required temperature a control thermostat initiates ignition and the energised electric torch is moved into the igniting position as the oil supply valve to the burner opens.

When the flame is established a flame failure photocell is energised and passes current which holds the solenoid-operated oil supply valve open as long as the burner is alight. At the same time the electric torch is de-energised and retracted.

When the burner is first lit it remains at low output until the boiler reaches approximately 60 per cent of working pressure, after which it burns at high output until the full working pressure is reached. The burner modulation then maintains a steady steam pressure in the boiler. If, due to small steam demand, the boiler pressure continues to rise with the burner on minimum output, the on/off device operates. The burner then shuts down and lights up again when the steam pressure falls. The modulating system is so arranged that under whatever condition the burner shuts down it always lights up again on low output.

A self-proportioning low-air-pressure burner used in a modified form in the above equipment is made by the firm in three sizes with capacities for 1 to 4 ; 1½ to 7½ ; and 3½ to 15 gallons per hour. These burners enable control of output by movement of a single lever giving correct air/oil ratio at all outputs. A steam-assisted pressure jet recently developed is designed to give a wide turn-down range without the complications of a spill return system or excessive fluctuations in oil pressure.

Alan Muntz and Co., Ltd.

An interesting design of direct air flow valve for compressors developed by Alan Muntz and Co., Ltd., Browells Lane, Feltham, Middlesex, is claimed to give low losses and be capable of operating at high speeds. The construction and principle upon which these valves operate can clearly be seen in the diagram (Fig. 27) in which

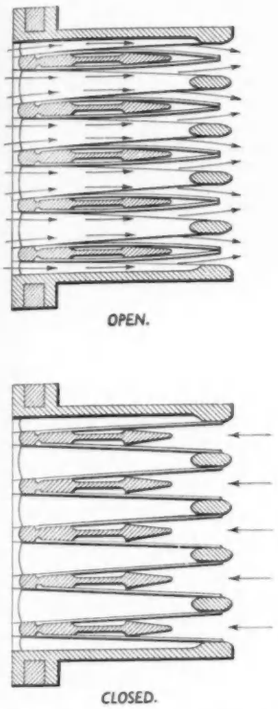


Fig. 27—Construction of automatic direct air flow valve for air compressors—Muntz

the valve is shown in its open (top) and closed (bottom) positions.

The valve has flexible sealing blades which are fixed along their leading edges to profiled central guide members. When the valve is opened by pressure of air the blades are bent back along the central members to provide smooth passages for the air to flow through. When the air flow attempts to reverse the blades spring back and their outer edges contact seating members to provide an effective continuous seal. With this form of construction no change of direction is imparted to the air flow when a valve is opened and frictional losses are very low. As the blades do not move bodily but progressively bend on valve opening and closing a smooth free action is imparted. The smooth, progressive blade movement ensures a long effective life and enables a valve to operate at high speeds.

Two general classes of valve are being made, one designed for low temperature operation on the suction side of compressors and to give the lowest possible losses. The second class, intended to withstand higher temperatures and more severe pressure reversals, have somewhat higher losses in service. The valves are rectangular in shape and are made in two standard widths of 2in and 3in and are available in lengths which are determined in relation to the required performance.

The number of sections in a valve can be selected in accordance with the required throughput ; for instance a low-temperature suction valve can have from four to fourteen blades and a high-temperature valve from four to twenty-eight blades. Thus the same type of valve can be assayed to cover a large range of throughputs. The design is such that pockets to contain the valves can readily be cast in a machine unit and all that is required is a flat machined sealing face to take the valve.

The maker states that in tests there was used a commercial air compressor, with converted plate valves, which was rated at 105 c.f.m. at 90 lb per square inch delivery pressure. When the plate valves had been replaced by a smaller number of direct air flow valves the output of the machine was increased by 20 per cent and the specific fuel consumption at full load was reduced by 12 per cent. In addition to its application in air compressors the design of the valve enables its use for a number of purposes where a quick acting check valve is required.

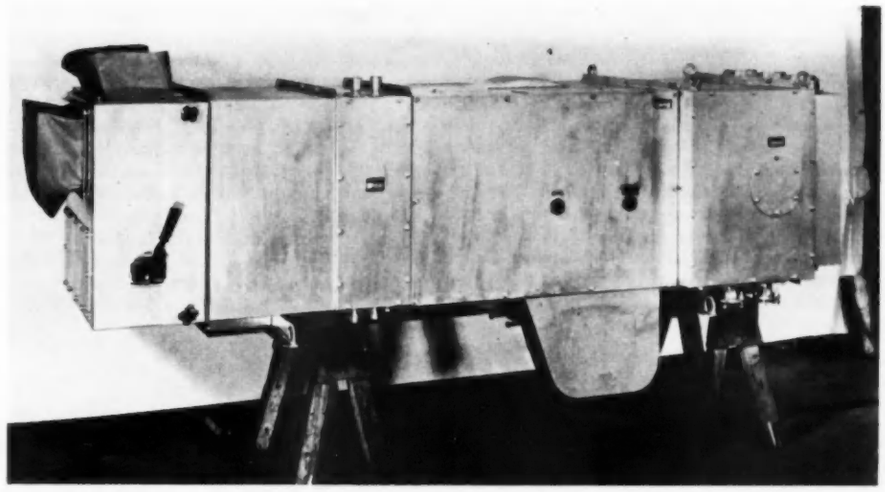


Fig. 28—Central air conditioning equipment incorporating heating and cooling coils and fan to treat air in accordance with changing climatic conditions on ships—Air Control Installations

Air Control Installations, Ltd.

The marine air conditioning systems which are supplied by Air Control Installations, Ltd., Ruislip, Middlesex, are designed for use with central air conditioning equipments such as that shown in Fig. 28. In these equipments the air is treated to a supply temperature, in accordance with the season and climate, for distribution to cabin units where the quantity delivered is individually controlled. Fresh air, return air or a mixture of fresh and return air is taken into the central equipment in proportions determined by the setting of manually or automatically operated dampers. The incoming air is filtered and in succession passes a heating coil, a fan and a cooling coil, where it is heated or cooled to the required temperature.

Conditioned air is distributed through supply ducts to cabin units, by which the quantity may be adjusted individually up to a maximum fixed for each cabin. The temperature is, however, adjusted at the central unit and the desired cabin temperature is determined by the quantity of supplied air. By enabling individual adjustment of the air delivered into each cabin pressure variations occur in the duct system. In order to maintain the adjusted supply of air to cabins, in spite of pressure variations, the cabin units have automatic quantity controls, which over a very large pressure range maintain the individually set air quantities.

The system may be designed as a low velocity system equipped with rectangular air ducts, dimensioned for an air velocity of 1000-2000ft per minute or as a high velocity system with the firm's small " Miniduct " tubes for velocities between 3000ft to 6000ft per minute.

The Royal Navy

Models will illustrate some of the more specialised marine engineering requirements of the Royal Navy and a working mock-up of a machinery control room, as being fitted in H.M.S. Devonshire, will represent the modern arrangement of automatic and remote controls necessitated to meet the possibility of nuclear warfare. For comparison purposes there will be a control room of an older frigate. A demonstration panel will show some of the different methods of remotely controlling a valve while an air compressor developed to deliver oil-free air essential for operating the pneumatic systems will be on view. Also on the stand will be a clutch which is incorporated in the gas turbine drive forming part of the combined arrangement of steam and gas turbine main machinery of guided missile destroyers. The synchronising clutch allows the gas turbine to be used for manoeuvring or as a boost to the steam plant. To dispense with a complicated reversing gearbox some of the diesel powered frigates and minesweepers have been fitted with a controllable pitch propeller of which a working example will be shown. The " Bullet Brush " method of cleaning boiler tubes, in which wire brushes are fired through the tubes by an L.P. Air gun, will be demonstrated.

Garringtons, Ltd.

The main exhibit of Garringtons, Ltd., Bromsgrove, Worcs., will be an automatic induction billet heating equipment to heat steel billets 1in to 2in square or round and 2in to 9in long to a temperature of 1250 deg. Cent. at a rate of 2000 lb per hour. In this heater the continuous billet feed eliminates electrical fluctuations by giving constant billet conditions within the heating coil. The feed device consists of a vibrator conveyor used with a double belt device which is easily adjustable to suit different billet sizes. A single-shot heating coil being exhibited is designed to demonstrate the rapid heating obtainable with induction heating.

The firm designs and manufactures induction billet heating equipment for many other purposes, as well as special purpose equipment for the continuous treatment of steel tube, bar &c. Where desirable the induction heating process is associated with alternative forms of radiant heating and equipment is now being made for ingot heating where the induction heating technique is used in close association with electrical radiation furnaces in order to reduce damaging side effects.

Serck Radiators, Ltd.

The heat exchange equipment on the stand of Serck Radiators, Ltd., Warwick Road, Birmingham, 11, will include a diesel locomotive cooling group such as that illustrated in Fig. 29, which is used on the D.800 type locomotives of British Railways. These groups are installed as complete assemblies incorporating the cooling surface and framework ; header tank with fillers and overflows ; fan set ; and interconnecting ductwork.

The group is fitted with the Serck/Behr hydrostatic fan drive and thermostatically operated shutters. In this fan control system the coolant flows round a thermostatic power element containing a wax-like substance which expands considerably when the temperature rises beyond a predetermined value. When this predetermined temperature is reached an actuating rod is forced out of the element and axially moves a spring-loaded plunger in an oil valve assembly. In the control sequence, when the engine coolant is cold, all the pressure oil delivered by a pump to the hydraulic motor of the fan flows through an open by-pass in the valve body and returns to the oil reservoir. The pump driving the fan motor is coupled to the main diesel engine fan drive in the conventional way. As the coolant water temperature rises the actuating rod of the thermostatic element moves forward and displaces the oil valve plunger axially and so restricts the cross sectional area of the by-pass. By this movement the amount of oil flowing to the fan motor is maintained proportional to the rise in the coolant temperatures. In this manner the speed of the motor coupled to the fan is regulated so that the flow of cooling air provided is only that necessary to maintain the coolant temperature in the engine.

In the pipe carrying the hydraulic oil to the fan motor an oil pressure builds up to a value approximately proportional to the torque of the fan, in other words, to the required fan performance.

To protect the fan motor against sudden undesirably high pressures the fan controller incorporates a pressure relief valve through which the oil can pass to the return pipe and so into the oil reservoir. This valve comes into action if the fan is for some reason mechanically prevented from rotating or if excessive pressures should build up during rapid acceleration of the drive motor. The pressure relief valve also protects the driving pump and the entire circuit against over-loading.

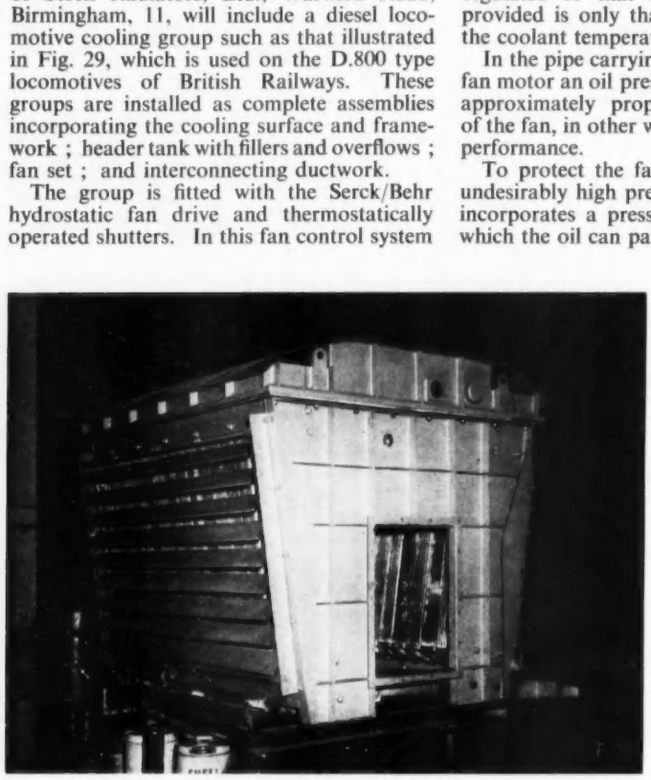


Fig. 29—Locomotive cooling group—Serck

Smith's Industrial Division

The ultrasonic flaw detection equipment made by Smiths Industrial Division, Kelvin House, Wembley Park Drive, Wembley, Middlesex, includes the Mark 6 unit shown in use in Fig. 30. This versatile instrument is designed for routine inspection in production establishments and laboratory investigations into the transmission characteristics of materials. It has a wide operating frequency range and includes a calibrated time base, delay and markers, stabilised power circuits and a 5in c.r.t. display.

The equipment operates with barium titanate probes having single, twin or separate transmitter and receiver heads and is suitable for contact, gap or immersion scanning techniques. Additional monitoring circuits can be incorporated to permit the use of semi-automatic inspection methods and provision is also made for the photographic recording of the cathode-ray tube. The equipment is mounted on a trolley incorporating an adjustable cradle which allows the display and control units to be positioned at a convenient angle for operation and viewing.

During the exhibition the above equipment will be demonstrated with a special rig for tube testing in conjunction with a Kelvin Hughes two-channel flaw alarm unit. This flaw alarm equipment facilitates the use of semi-automatic inspection techniques, so removing the onus of signal discrimination from the operator. With it, defects within the selected range of discrimination are immediately and automatically identified and are indicated either visually or audibly.

The equipment allows the simultaneous examination of two independent regions in the material under test, automatic indication of defects, independent adjustment of depth, position and degree of sensitivity within each region under inspection. The research region is shown on the cathode ray tube as a brightened section of the trace (i.e. " gate "). Gate position and width can be varied continuously over three ranges to give coverage from 2·5 to 3500 milli-seconds and can be positioned to overlap, either partially or completely, so permitting a portion of the whole cross-section of material to be examined at two levels of sensitivity. The sensivity of each channel can be adjusted independently. At the maximum setting a signal of $\frac{1}{8}$in high appearing in the brightened section of the trace (which is equivalent to a 10V peak signal) will actuate the appropriate flaw warning light.

In Fig. 31 there is shown a recently developed panel for the automatic protection of internal combustion engines against damage resulting from fuel or oil pressure failure and excessive coolant temperature. This equipment can also be used for any application that requires a signal to be made at predetermined pressures and temperatures within the wide range of instruments available.

The main items on the panel are two contacting gauges and it includes other instruments and equipment that can be varied according to requirements. The panel on exhibition will consist of a contacting pressure gauge ; a contacting thermometer ; an ammeter ; a three-position start-preheat-

Fig. 30—Ultrasonic flaw detector—Smiths

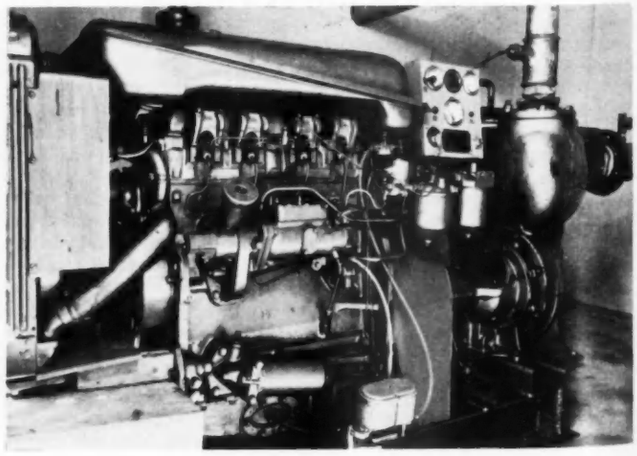


Fig. 31—Panel for the automatic protection of i.c. engines—Smiths

starter switch; a priming pump; a stop button; and an additional instrument, such as a gauge for indicating water pressure or air pressure—or, possibly, a tachometer—to suit the application.

G. and J. Weir, Ltd.

Two new evaporators have been added to the range of land and marine equipment made by G. and J. Weir, Ltd., Cathcart, Glasgow. The two-stage flash evaporator shown in Fig. 32, is the smallest model of a new range of marine evaporators with outputs of 20 tons to 75 tons per twenty-four hours. Of compact design, this plant incorporates a distilling condenser, external feed heater, brine and distillate pumps and a steam jet air ejector. It employs the once-through principle of brine circulation and incorporates demister screens of finely-knitted monel metal wire to prevent carry-over of water droplets with the vapour.

A submerged-tube-design "D1" marine evaporator has been designed for use in motor vessels and employs main engine cooling water as the heating medium. It is of vertical cylindrical construction and made in six standard sizes with outputs from 5 tons to 30 tons per twenty-four hours. These plants incorporate brine and distilled water pumps, an air extraction pump and a distilling condenser.

A high vacuum exhaust steam turbine developing a maximum of 650 b.h.p. at the shaft extension has been developed by the company for use on motor vessels where high pressure steam is not available. Of horizontal geared design this simple impulse turbine has one pressure and two velocity stages. It is designed for steam supplies up to 250 lb per square inch and 750 deg. Fah., the shaft speed being infinitely variable up to a maximum of 1200 r.p.m.

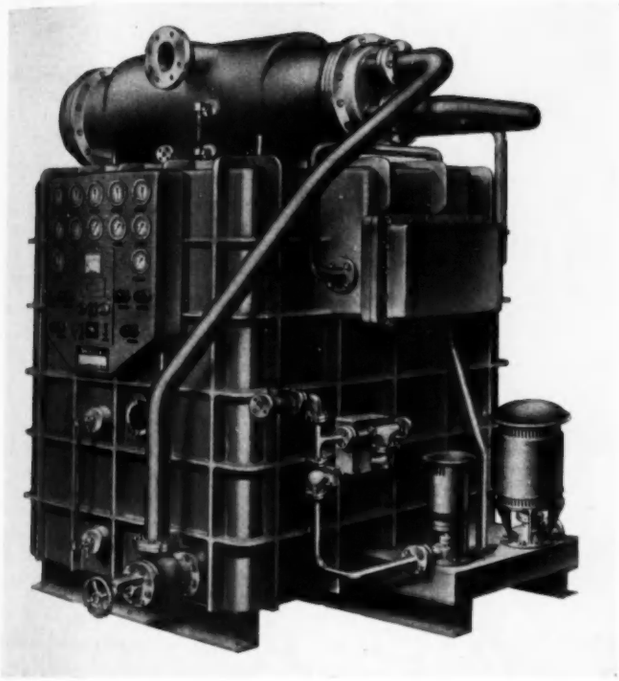


Fig. 32—Two-stage flash evaporation and distillation plant for marine or land service—Weir

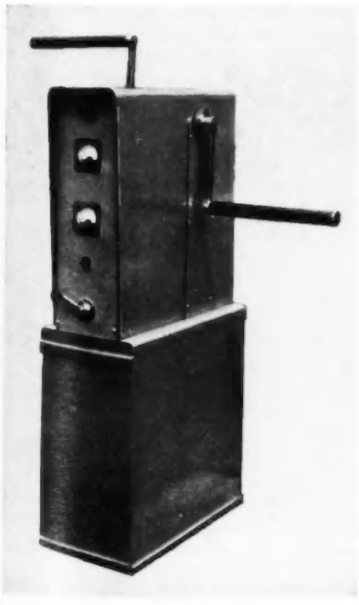


Fig. 34—Manually-driven electro-dialysis plant for producing fresh-water from sea-water in ship's lifeboats—Weir

An interesting product of a subsidiary company—the County Water Softener Company, Ltd. is an apparatus for emergency production of fresh-water from the sea in ships' lifeboats. This device (Fig. 34) operates on the electro-dialysis principle and is worked by two persons turning handles at each side of the casing. Electricity is generated for the electro-dialysis process and is also used to work a radio transmitter which automatically sends an S.O.S. signal. The apparatus produces about 2 gallons of fresh-water per hour.

W. and T. Avery, Ltd.

An electrodynamic balancing machine of 250 lb capacity exhibited by W. and T. Avery, Ltd., Birmingham, is fitted with a twin "Vectormeter" indicator head and plane compensator. These vectormeters, with light spot indication, have been introduced so that unbalance readings can be expressed in the most conspicuous manner.

The photograph reproduced in Fig. 33 shows the frontal appearance of an instrument in which the light spot is displaced from the centre zero so that the radius at which it settles represents the amount of unbalance, and the position on the scale the angular location on the rotor being tested.

Each vectormeter has two wattmeter instruments spaced at 90 deg., one arranged to deflect the light spot vertically with the aid of a mirror, while the second acts independently and deflects the light spot horizontally. The indicated result is fixed by an electromagnetic locking device so that need for writing down and recording the readings by an operator is eliminated. The front scale of the vectormeters can be exchanged so that a polar display can be replaced by a special diagram from which components of 90 deg. or alternatively 120 deg., can be quickly seen by the operator.

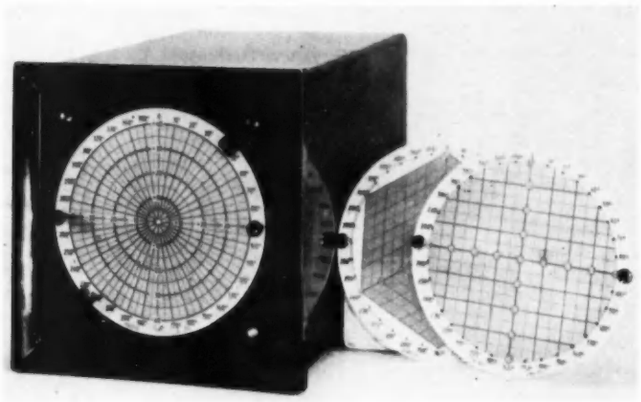


Fig. 33—Vectormeters with light spot indication for balancing machines—Avery

Two of this firm's universal testing machines are to be shown—one fitted with a new design of self-contained servo-operated autographic recorder, the other having a high-temperature furnace and control. This second machine of 25 tons capacity accommodates single or multiple furnace units

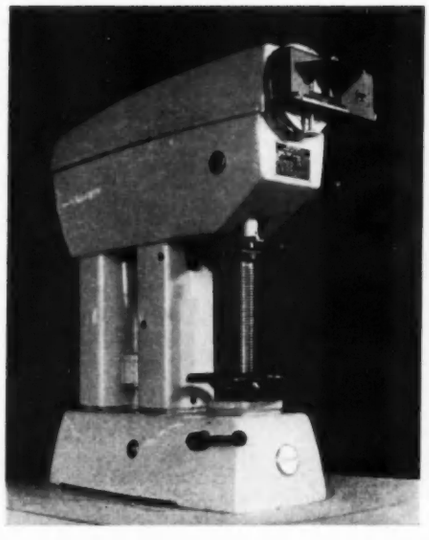


Fig. 35—Visual hardness testing machine—Avery

for temperatures up to 900 deg. Cent., with means for the simple and safe insertion and removal of test pieces. It has a high magnification extensometer working on gauge length of the test piece and coupled to an autographic recorder for the rapid determination of proof stress, plotting of head extension curve and giving magnification up to 1000/1.

A 120kg Vickers diamond pyramid hardness testing machine now made by Avery has a dual magnification microscope, by which a magnification of ×350, provided in addition to the standard ×70 magnification gives a high reading accuracy on small impressions. The instrument (Fig. 35) has optical projection of the image on to a screen and an improved reading device operated by a digital micrometer facilitates rapid reading of impression size.

Modern Wheel Drive, Ltd.

Three examples of oil-operated, reverse-reduction, marine gears to be demonstrated in operation by Modern Wheel Drive, Ltd., Lindo Lodge, Stanley Avenue, Chesham, Bucks, include the firm's first two-speed gearbox of this design. This gearbox, illustrated in Fig. 36, will have a transparent cover to show its operation and layout. It is to be installed with a Lister-Blackstone engine on a trawler being built by T. Mitchison, at Gateshead-on-Tyne. The gearbox is designed for an overload rating at the input coupling of 726 h.p. at an engine speed of 750 r.p.m., or a continuous rating of 660 h.p. at 750 r.p.m. For the free-running condition the ahead ratios are 3·02 : 1 and for trawling purposes 3·49 : 1 ; whilst the astern ratio is also 3·02 : 1.

The input shaft carries three pinions—the forward and aft pinions being for the ahead rotation, and the centre pinion for astern rotation. The ahead pinions are in constant mesh with gear wheels containing the "Hindmarch/MWD" oil-operated clutch and supported on splined clutch shafts. These clutch shafts also carry the astern gear wheels and clutches, which are driven through idlers from the input astern pinion. The final reduction pinions are mounted on the clutch shafts and are in constant mesh with the final wheel which is carried on the output shaft.

Another interesting exhibit on this stand will be a wooden model of the cable installation in the new G.P.O. cable ship "Alert," which has two "Telcon/Hindmarch" oil-operated cable winch winding gears. These multi-speed gears each have gear ratios of 182 : 1, 91 : 1, 46 : 1 and 20 : 1.

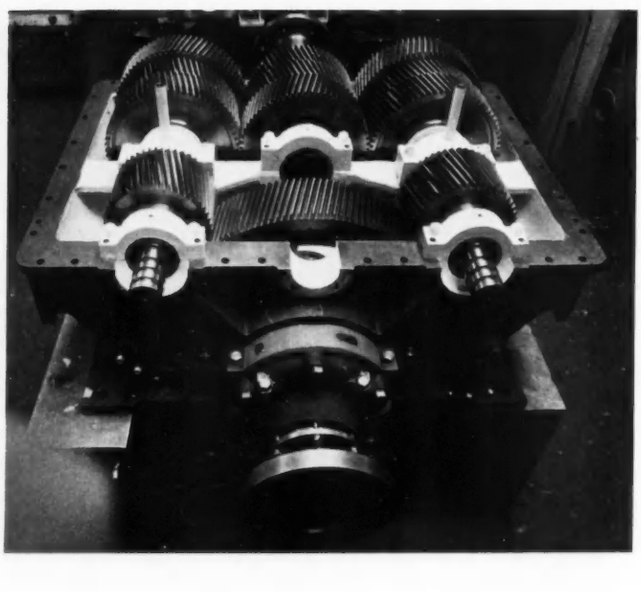


Fig. 36 — Oil-operated reverse-reduction two-speed gearbox—Modern Wheel Drive

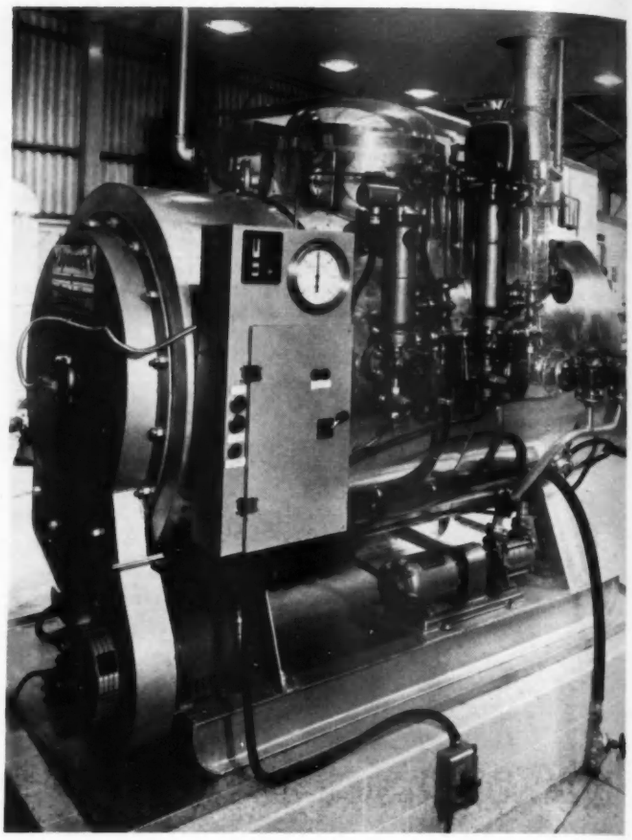


Fig. 37—Heating boiler for supplying 1000 lb of steam per hour from 60 deg. Fah.—Spanner

Spanner Boilers, Ltd.

A Mark 3 "Swirlyflo" boiler introduced by Spanner Boilers, Ltd., Wokingham, Bracknell, Berkshire, is available in outputs from 600 lb to 10,000 lb per hour and is suitable for marine, land and train heating applications. In this boiler (Fig. 37) uneven stresses are avoided by making the furnace concentric with the shell and the vertical tube plates do not collect mud and scale. The helically grooved tubes are arranged on each side of the furnace to facilitate inspection and, as there are no tubes underneath the furnace, a large space is provided for the collection of mud, which cannot easily build up to a depth at which it will touch the tubes and cause overheating.

The oil burner is so arranged that the combustion elements can be easily removed from the boiler for cleaning and adjusting without disturbing other parts. The arrangement of the dome on top of the boiler, with internal steam drying, ensures the delivery of very dry steam. A relatively small water content gives quick steam raising with this design of boiler and it is stated that, although the boilers have a relatively short length, efficiencies in the region of 82 to 84 per cent are obtainable.

(To be continued)

Traffic Engineering for Airports

THE central figure at the March 23 meeting of the Traffic Engineering Study Group, at the Institution of Civil Engineers, was Monsieur H. Grimond, the eminent French traffic engineer, a principal of the Societé d'Etudes Techniques et Economiques, whose recent responsibilities have included the traffic engineering for the airports of Orly and Le Bourget (including their access routes) and also the preliminary traffic studies for the Channel Tunnel project. Monsieur Grimond's paper was entitled "Traffic Engineering Problems on Motorways Between Cities and Airports in France", from which it is not to be imagined that terminal problems were excluded; they took up much of the paper and most of the discussion. Furthermore it transpired that Monsieur Grimond had been modest in his title, for it was largely French solutions and British problems that kept the discussion going—for a full two hours; Orly seemed somewhat in advance of London Airport. With his mastery of the subject—and of the English tongue—Monsieur Grimond gave the Group a memorable evening. Mr. H. J. B. Harding was in the chair.

Orly lies approximately 14km due south of Paris, Le Bourget an equal distance north-east. It is estimated that in 1965, allowing for the growth of traffic and for road improvements completed meanwhile, the road journey to either airport will take 32½ minutes (plus or minus two minutes) from points in central Paris at an equal travel time from both. Orly has an advantage at present, being served directly by a main highway (R.N.7) and also by the South Throughway; a speaker reported that it is a very pleasant bus journey to or from Paris by "this wonderful throughway," and another told of reaching Orly by car from the Eiffel Tower in twenty-five minutes, though that was with police escort.

The French reliance upon roads, rather than helicopters, monorails, or railways, between city and airport, is based on the flexibility of road transport. A road can be used by every sort of motor vehicle simultaneously; wide fluctuations in the volume of traffic do not present any problem; and everyone's waiting time is minimised. The paper also explained that for Orly's peak of 3000 passengers per hour helicopters could not be considered—for reasons of air space. Monorails were mentioned in the paper only as a possible British innovation; it struck one questioner as odd to find this in a paper of French origin, for the British press constantly reports monorails imminent in France! In reply it was pointed out that decisions in these matters do not always depend on economics or on engineering considerations; but the meeting received an impression that between Paris and Orly there will never be a monorail, and only improbably a railway. A railway from Austerlitz station in Paris has indeed been approved in principle, as a long-term project, but the paper showed that it could not better the overall travel times already yielded by the bus services it would replace.

On behalf of London Airport (Heathrow), in comparison with Orly, the claim was made that it deals with four times as many passengers. And the distance is greater, 17 miles being the shortest practicable rail alignment from the nearest of the London main line passenger termini, Victoria. Road access, at present by trunk road A.4, will be much improved by the construction of the first stretch of the South Wales motorway in prolongation of the Great West Road, from which there will be a link, leading under A.4, direct to the twin road tunnels through which all road traffic gains final access to the airport proper. The tunnels have two-lane carriageways, rendering them fully adequate until at least 1970, by which date—on the assumption that 48 per cent of the air passengers will use buses and 52 per cent cars—the peak flows are estimated to reach 5000 vehicles per hour; currently the tunnel traffic does not exceed 26,000 vehicles a day.

Quick access to the terminal building, from both the north and from Fontainebleau, had been Monsieur Grimond's primary aim in designing the internal traffic circuits at Orly. He complained of having to live with a master plan approved before he came on the scene; but the final lay-out, which he displayed in a series of slides, contained no apparent improvisations for the meeting to criticise, and the facility with which it had been possible to employ grade separation at the two most important intersections was duly admired. Elsewhere at Orly the circuits were seen to conform very well with the conclusion reached in British studies made during the planning of London Airport, to the effect that—flyovers apart—time is saved by arranging for the traffic to keep moving, rather than by minimising the mileage travelled; large gyratory systems are preferable to a multiplicity of roundabouts.

Parking occupied much of the discussion. At Orly the original plan was to have 6600 spaces by 1972, but already only the more remote parks remain to be completed. At London Airport the ultimate requirement is estimated at 14,000; the meeting was told that last summer the available 4000 spaces were at least 1800 short of the demand and high prices had been imposed to keep people away. Short-time parking close to the main terminal buildings is provided at Orly by means of meters along both sides of the frontage approach road, with a spur to provide additional kerb space. At London Airport the first half-hour in front of the building is free, and overstayal is discouraged by a stiff charge for extra time, though it came to light in the discussion that the authorities would like overstayal to constitute a legal offence, which it does not at present on airport property. At both airports, though more especially at London, this close-to parking is potentially in far greater demand than the available area will satisfy; relief measures are being investigated, including the use of more spurs at Orly, and platforms at London; a speaker pointed out that only double-deck road construction, segregating arrivals and departures at different levels and doubling the available area, could eliminate this problem at airports.

In order to economise in manpower Orly's parks are equipped with imported automatic ticket machines and gates, but the meeting was warned not to imagine that these devices are completely reliable and trouble-free. The distances to be walked at airports after parking one's car—if one manages to park it!—gave rise to a number of lighter contributions to the discussion, but it transpired that at Orly they have not been unmindful of this problem; the lessees of the more remote parks are to be placed under an obligation to ferry their parkers to and from the terminal by car or bus. Parking surveys at Orly have shown that the various classes of parker occupy spaces for the following average periods: drivers bringing or meeting air passengers, 56 min. (95 per cent less than 2 h.); self-driving air passengers, 2½ days; air crews, 2½ days; other employees, 2 h. 36 min. at a time; callers, on business, 52 min. (92 per cent less than 2 h.); *Curieux* (Angl. spectators), 1 h. 5 min. (93 per cent less than 2 h.).

As part of the continuous search to save passenger-time the Paris bus terminal at Les Invalides has been kept under observation, resulting in two innovations. Passengers will no longer register their luggage at this terminal, for it had been found more expeditious to carry out all registration at the airport. One speaker registered a complaint about this: he preferred to be rid of his luggage as early as possible. The second innovation arises from the use of taxis by 67 per cent of the bus passengers when making their way to the Paris terminal or quitting it. To eliminate some of these transferences there are to be six-seater limousine services between Orly and convenient destinations in the city, calling where required—within reason. This scheme gave rise to some remarks on the affluent society, and on the curious non-availability of taxis and limousines whenever they are needed most, but its sponsor squared the account, and more, in the same coin.

The point was made early in the meeting that a passenger's time is put to phenomenally good use in the air nowadays, which accentuates the wastefulness of any unnecessary delays at either end of his journey. Accordingly time-saving becomes more than ever the ruling consideration throughout the comprehensive planning of an airport, and in this climate traffic engineering comes into its own; but, as always, it must be based on adequate data; the origin and destination studies have to be very extensive to cover all airport users. The final stage of the meeting took the form of an extempore address by Monsieur Grimond on his experiences in traffic surveying and the succeeding processes of analysis and forecasting. His mention of the use he had made on various occasions of the periodical national census returns aroused special interest with a census imminent in this country. In one instance, in Algiers, Monsieur Grimond had been able to arrange for the insertion in the census form, at only three or four months' notice, of extra questions concerning the daily movements of the population. The possibility of the British census becoming eventually of comparable traffic engineering value provided a last item for discussion.

Industrial Double-Triode

FOR switching, computer and similar applications where close matching of two triode systems is required, a G.E.C. double-triode valve, A2900, has been introduced by the M-O Valve Company, Ltd., Brook Green, Hammersmith, a subsidiary of The General Electric Company, Ltd. The valve is fitted with the B9A base and has been designed to replace the international type 12AT7, particularly in applications where long life and reliability are essential. Since the characteristics are similar in many respects to the 12AT7 and dimensions and base are also alike, no circuit modifications are required in most applications. Life expectancy is stated to be up to at least 10,000 hours under approved working conditions. Anode current differences between the two triode sections, according to the specification, will not exceed 1·25mA over a mean average spread of 10·5 ± 1·5mA, while mutual conductance between the two systems will not differ by more than 1mA/V over a mean average of 6·2 ± 0·8mA/V. A guarantee exists for the A2900 covering lives up to 10,000 hours.

LETTERS AND LITERATURE

Letters to the Editor

MILLIONS TO BE SAVED ?

SIR,—Mr. Huson apparently believes that when I suggest road users do not pay enough in taxation for all the services they enjoy I am not serious. Perhaps the following very approximate figures will convince him of my sincerity.

Expenditure by local authorities 1957-58 on highways and bridges	£103,800,000
Cost of maintenance, improvement and new construction on roads by M.O.T.	£166,000,000
Public lighting £15,690,000, say	£7,000,000
Police £95,152,000, say	£50,000,000
Road accidents	£200,000,000
Total	£526,800,000
Taxation from road vehicles	£111,500,000
Taxation from fuel (1959)	£337,300,000
	£448,800,000

These figures are admittedly approximate, and do not include other very substantial subsidies which the road user enjoys—free parking for example. It is against these figures that one has to judge whether the railways are, in fact, outworn and fit for the scrap heap.

Some of your correspondents have suggested that motor vehicles are no more dangerous than trains. This, I find difficult to believe—heavy propaganda exhorting motor cyclists to wear crash helmets and motorists to fit safety belts does suggest that road vehicles are inherently dangerous. Quite clearly road transport is gaining ground at the expense of the railways, because the former is heavily subsidised and this is something which does a great deal of harm to the community as a whole. Both road and rail transport play a vital role in this country's economy and it is most important that we examine the problem of relative costs as objectively as possible.

Perhaps it may relieve Mr. Huson of the suspicion that I am biased when I mention I run two cars, but he may be assured that my excursion into this correspondence is motivated only by a desire to know the full facts.

J. V. WALKER

Solihull,
March 30, 1961.

SIR,—When replying to Professor Tuplin on March 17 you explained that, in its original form of " Thousands of millions to be saved ? " the title of this correspondence related to capital expenditure. But in terms of millions, or hundreds of millions, it is, I submit, equally appropriate in a revenue context. For one thing, had there been no British Railways, taxation could have been reduced by the amount of the railway subsidy—£105 million in 1960-61 ; £103 million in 1961-62. The Minister of Transport has himself translated this as 4d. in the £ on income tax, showing vividly enough how railway non-existence (which is implicit in railway conversion) would begin to spare the citizen's pocket. In addition the Parliamentary Secretary has stated that the Treasury provided a further £160 million " as investment in the railway industry " in 1960 ; £140 million has been promised in like manner for 1961 ; it is many years since money for this purpose could be raised in the market. Yet certain of your correspondents permit themselves to write as if the railway industry were not ailing ! They should realise that it is desperately sick, with death itself being staved off only by the National Wealth Service at full stretch. Under these circumstances every characteristic of rail transport must be held suspect—suspect of being one of the many roots of the trouble. But, with blind belief, your pro-railway correspondents put forward these characteristics, one after the other, as benign, never evil.

Typically, Mr. Harding sees unquestionable merit in confining vehicles to one vertical plane, along a pair of rails or beneath trolleybus wires ; and Mr. Dahl gilds this " principle of rail guided traffic " with his faith in the chaining together of vehicles into trains. These techniques may delight the operator, but the £105 million deficit shows that they probably do not delight the customer. I offer the suggestion that every powered vehicle should be regarded as a living thing, or even as a living person—its driver, endowed with rare powers of speed, lift, and endurance. To hold it captive to a rail or wire, or tie a mass of deadweight to its tail, or work it in chain-gang, can then be seen as almost a form of cruelty. But the real mischief is that the vehicle is thereby hampered in serving the public. A simple illustration of this was provided by Mr. Nock when he assumed that buses would have to stop at every station between King's Cross and Paddington just as the trains do at present. He forgot that free-running road vehicles have the gift of being able to meet people's demands precisely, and to do so without getting in one another's way unduly, if at all. The bus services on the Inner Circle, and throughout the converted railway system, could comprise any desired mixture of express, non-stop, and stopping services. The stations, with platforms removed, would be wide enough for the bus stops to flank the road without obstructing the through lanes, which would unfailingly, throughout all hours of the day, furnish free-flow conditions for other buses and other motor vehicles of every sort up to the full capacity of the road.

Although capacity figures again and again in this correspondence in connection with fare-paying passenger traffic, the truly relevant point is that this country is too generously railroaded for any one railway route to serve a resident population large enough to tax the capacity of the bus services on that route after it has been converted. Critics often admit that this capacity should be not less than 40,000 bus passengers per lane per hour ; but, they protest, it has never been demonstrated. It may be demonstrable ultimately by finding a route with 20,000 passengers and hiring another 20,000 for the hour ! Meanwhile a recent American report has revealed that " 20,000 to 25,000 persons per hour are regularly moved in buses in a single lane of the Lincoln Tunnel with ample room for many private cars as well," which provides a ready-made answer to Mr. Nock's Inner Circle problem of 17,250 passengers per hour. Possibly Mr. Nock's figure is too low, for a professional paper says " it is improbable that the traffic ever exceeds 30,000 in a full hour " ; but even that figure would not be impressive in the light of what is going on, as a matter of course, in the Lincoln Tunnel. Moreover ordinary surface railways have only about one-third of the capacity of the Underground, whereas the capacity of a road is somewhat greater on the surface than in a tunnel.

Mr. Nock also asks how the traffic could be dealt with during conversion. Underlying this question there is doubtless the notion that the railways carry too much traffic to permit of disturbance. I have already pointed out that on the average day only 1,500,000 of the population use B.R. as passengers—which means that 48,500,000 do not. The proportion of inland goods traffic carried by the railways, which was 60 per cent in 1938 and 42 per cent in 1959, is now perhaps 40 per cent. Curiously, in the transport debate on January 30, Mr. G. Wilson, M.P., used this fact—that B.R. are still carrying a not inconsiderable amount of freight—in order to reprove the R.C.L. for calling railways obsolescent. It was as though, eighty years ago, the then Member for Truro had declared that since sailing ships were still carrying 40 per cent of ocean freight they could not be obsolescent ! My point is that when things become obsolete the inconvenience of replacing them has to be faced ; but in this instance it is only the " junior partner " (your phrase) that is going out ; with careful planning, the senior partner, in the form of the highways, will be able to bear the temporary, highly localised, extra load during a conversion that will bring into being, progressively, a yet more senior partner.

T. I. LLOYD

Guildford,
April 2, 1961.

AIR-COOLED DIESEL ENGINES

SIR,—In your issue of March 10, page 362, you very kindly mentioned a symposium on the air cooling of diesel engines which was presented to this Association in January last. When the symposium was given, the author of one of the papers, Mr. John Smith, M.I.Mech.E., director of Petters, Ltd., drew attention to a printing error, repeated in your reference, in the advance copy which has caused both him and his company some concern. The error related to an air-cooled diesel engine in which cylinder wear rates were given as 0·002in per 1000 hours instead of the correct figure of 0·0002in per 1000 hours. I should be grateful if you would publish a correction.

A. P. QUARRELL

Diesel Engineers and Users Association,
18, London Street, London, E.C.3,
April 5, 1961.

Book Reviews

Heat Transfer Engineering. By HILBERT SCHENCK, Jnr. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 28s.

THE object of this book is to give the student of heat transfer confidence to tackle problems arising in this complex subject, and a broad knowledge of its extent and capabilities. One's first impression is that it achieves this aim, but closer acquaintance shows the book to be so riddled with inconsistencies and even downright inaccuracies that it seems more likely to mislead and confuse the average student than to enlighten him. This is a pity ; there is a good case to be made for the author's method of discarding (temporarily, of course) many of the more formally analytical sections of the field of study and presenting to the student a unified picture of the subject from basic physical ideas to advanced computational procedures. The author has a lively mind and a lively style of writing, and has put into the book much material to stimulate the readers interest, by describing, for example, important applications of heat transfer theory to present-day engineering problems—nuclear reactors, high-speed missiles and the like.

To the student, however, accuracy of presentation is of greater importance than style, and it is in this respect that the book fails to command confidence. Take, for example, section 11.4, which describes the general form of standard experimental determination of heat transfer coefficients in forced convection. In this section, in five pages of text, there are two incorrect references to a previous equation, two pairs of indirectly contradictory statements concerning the desirable relative magnitudes of the coefficients of the test fluid and the reference fluid, a numerical mistake (fortunately not serious) in a worked example, and the use, in three places each, of two different symbols for the same quantity ; also the following sentence describing recommended treatment of results when energy quantities calculated from experimental readings do not balance—"In this case, the engineer must critically examine his data and throw out one of the six basic experimental quantities, usually the one which is the most suspect." No further comment appears necessary here. Additionally, although in the preamble to this section it is made fairly clear that the purpose of such an experiment would be the determination of fluid-to-wall heat transfer coefficients, there is no mention of the measurement of wall temperature which would make this possible without recourse to the rather unsatisfactory "modified Wilson plot" which is described.

Section 11.4 may well be the least accurate in the whole book. It is certainly not typical, but errors do occur elsewhere. The treatment of units is the sort of mess one expects to find only in pre-war books. The clearest part of the discussion of units declares that the pound mass and pound force will be used, yet there is a failure to introduce the appropriate dimensional constant (g_o or g_c), the best way of making this clumsy system workable for students : we find, among other things, shear stress expressed in units of pounds mass per square foot; expressions for several dimensionless groups which are inconsistent with the chosen unit system; and the following equation, which, taken literally, implies a very sticky time indeed for travellers in outer space,

$$\tau = \frac{\mu}{g} \cdot \frac{dV}{dy}$$

in which the symbols have their usual meaning in fluid mechanics.

Let the index provide the subject for a final comment before summing up. The index contains many items, most of which are, no doubt, useful ; but there is a quite unnecessary number of trivial or pointless items, and even a few that are frankly ludicrous.

Enough has by now been said to show that in its present state the book is not fit for student use. However, we have no hesitation in saying that the position could be completely reversed, were the book to be thoroughly revised. It contains many excellent features. Although only moderately well produced, with rather cramped pages and undersized diagrams on the usual English textbook pattern it could, after revision, be really excellent value at its price.

Materials for Nuclear Engineers. Edited by A. B. MCINTOSH and T. J. HEAL. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 75s.

THIS book aims at presenting the best data available on materials of interest for the core of a nuclear reactor, together with sufficient discussion of the data and their fundamental background to allow intelligent interpolation and extrapolation. The introductory chapter, by Dr. McIntosh, discusses the use which nuclear engineers may make of data on the properties of reactor core material under the headings : "Occurrence and extraction"; "Physical properties"; "Mechanical properties"; "Extrapolation of creep data"; "Hardness"; "Compatibility"; "Fabrication, and effect of reactor conditions." The chapters which follow are written by separate authors who use a similar framework of sub-headings in dealing with Uranium, Plutonium, Thorium, Ceramic fuels, Graphite, Magnesium, Beryllium and Zirconium. It is fortunate that the development of all the chapters is logical and similar because the index to the book does little more than expand the framework of the chapters with little cross-referencing between them. On the other hand, both the text and the data sections are fully indexed with something approaching 400 references to the original sources of information. Each chapter contains a considerable amount of data in the form of tables and figures within the text, but the main concentration of data follows each chapter, under the headings, "Physical properties"; "Mechanical properties"; "Compatibility and nuclear properties." So extensive are the references, tables and illustrations, that the book can be rated as excellent for data collection or for tracing original sources of information.

However, there are some slight limitations. The book is aimed principally at the design engineer concerned with the reactor core. This does not mean that a metallurgist, for instance, would find the book uninteresting. It will be of considerable interest to him but he will not find the mechanisms of alloying, phase transformations, oxidation, thermal cycling and irradiation growth considered in detail. There is a curious anomaly here, in that no alloy system elsewhere in the book is illustrated by its equilibrium diagram, but under plutonium data, no less than sixteen of its alloy systems are so illustrated, with little encouragement from the text.

The extraction and fabrication aspects of the materials are treated briefly, but sufficiently well in most cases for the reader to appreciate the complexity of these operations. The way in which extraction and fabrication markedly affect costs of reactor materials could have been outlined more clearly though the case is reasonably well stated for beryllium and plutonium. The worst omission of this kind is that the cost of enrichment of fuels is not compared economically with the possible advantages which are gained in design. The materials dealt with reflect mainly recent British approaches to reactor design, so that liquid metal coolants, liquid fuels, niobium and stainless steel applications receive comparatively little attention. Another omission, which it would not be difficult to remedy, is the complete absence of any reference to reactor pressure shells.

The book is well finished and both type and illustrations have the clarity desirable in one which will be used mainly for reference purposes. There need be no hesitation in recommending it to the attention of reactor design engineers and metallurgists as a first-class data book for the field it sets out to cover. The only caution necessary is that this is a field under constant development, and fresh data and interpretations as they are released will necessitate revision from time to time. In this respect it is worth noting that the latest dated references do not extend beyond 1959.

Hydraulische Pressen und Druckflüssigkeitsanlagen. Vol. III : Strang- und Rohrpressen für Metall- und Kabelwerke. By ERNST MULLER. Berlin-Göttingen-Heidelberg : Springer-Verlag, Berlin - Wilmersdorf, Heidelberger Platz 3. Price DM.43.50

THE third and last volume of *Hydraulic Presses and Pressure Installations* deals with extrusion presses for non-ferrous rods and tubes, with particular reference to metal and cable works. Because the machines employed are broadly of similar design, it was found possible within the framework of a single volume to go into a substantial amount of design detail and to cite examples of calculations based on many years of practical experience. While much has been published concerning the technology and metallurgy of the deformation processes involved, very little has appeared about the design and development of the presses and press tools, other than brief articles in journals, so that it is felt the present work will fill a gap in the available literature and as such will be welcomed by designers and production engineers, as well as students.

Books Received

An Introduction to Electrotechnology. By S. Kowalski. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 35s.

Machine Shop Operations and Setups. By Porter-Lawshe-Lascoe. The Technical Press, Ltd., 112, Westbourne Grove, London, W.2. Price 48s.

Translation from Russian for Scientists. By C. R. Buxton and H. S. Jackson. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 30s.

Basic Ultrasonics. By Cyrus Glickstein. John F. Rider, Publisher, Inc., New York, Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 32s.

Determination of the Mechanical and Technological Properties of Metals. By B. M. Gliner. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 50s.

Calculus and Analytic Geometry. Third Edition. By George B. Thomas. Addison-Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 53s.

Berechnung und Gestaltung von Metallfedern. By Siegfried Gross. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3 (West-Berlin). Price DM21.

An Introductory Treatise on Dynamical Astronomy. By H. C. Plummer. Dover Publications, Inc., 180, Varick Street, New York 14, New York. Price 2.35 dollars.

Introduction to Modern Physics. By C. H. Blanchard, C. R. Burnett, R. G. Stoner, and R. G. Weber. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 37s. 6d.

Rockets and Space Flight, 1960

By JOHN E. ALLEN*

No. II—(*Continued from page* 512 *March* 31, 1961)

Progress during the first year of a new decade—which will be the first complete decade of space flight—is being reviewed under the headings of rocket propulsion systems, rocket propelled vehicles (including satellites and space probes), and man-in-space. Future trends, as shown by such details as have been released, are indicated wherever possible.

ROCKET PROPELLED VEHICLES

Large Missiles

PROGRESS in the missile field has been thoroughly summarised in Reference 33, and many details were given in a previous article,[1] so that only the main outline of developments need be mentioned here.

Since the first " Atlas " I.C.B.M. flight in June, 1957, and up to October, 1960, there were seventy " Atlas " launchings—fifty-one of these were successful or partially successful, but there were some spectacular failures among the rest. " Atlas " will be used for the first stage of " Mercury," " Centaur," " Midas " and " Samos " vehicles. It has already been used with " Able " or " Agena " second stages for space launchings. Britain's " Blue Streak " I.R.B.M. was cancelled in April when total costs had reached £65,000,000 ; first flights would have been made about April, 1961. " Blue Streak " was cancelled as a weapon owing to its lack of mobility, for it was designed for fixed bases, and the project has been marking time ever since in the hope of government support for its use as a space vehicle launcher. American strategists, however, find strong reasons for " Atlas "—in spite of its lack of mobility—in its high degree of dispersal, distance from possible enemies, and great numbers : total deployment amounts to over 120 missiles, each one of which would have to be destroyed to avoid its use in retaliation. Deprived of the impetus and financial backing of military interests, " Blue Streak's " only hope is now its choice as launcher for co-operatively developed European vehicles, about which more will be said later.

" Titan " I.C.B.M., the latest—and probably the last—of America's large liquid propellant missiles, has made ten successful flights between February, 1959, and October, 1960, and the first operational squadron is expected to be deployed in underground silos by about summer, 1961. The first operational prototype, however, launched on July 1, 1960, had to be destroyed by command. There have been numerous other failures during development, and there was also a spectacular one on the night of December 4, 1960 ; a " Titan " was being fuelled in its underground silo at Vandenberg Air Force Base prior to a test flight, but it exploded in the silo—causing damage estimated at about 5,000,000 dollars. " Titan's " main spaceflight use will probably be as booster for the manned " Dyna-Soar " orbital vehicle. The " Jupiter " I.R.B.M. completed its development flights in February, and is to be deployed in northern Italy and Turkey.

In missiles, the year nevertheless undoubtedly belongs to the solids : the success of the " Polaris " I.R.B.M., one of which is seen being loaded into a nuclear-powered submarine of the U.S. Navy in the heading photograph, made a tremendous impression on strategists and the public alike. The launch and ignition of a " Polaris " from a depth of about 200ft on April 14 was followed by the full firing of two " Polaris " vehicles on July 20, and by a flight of 1300 miles, only 200 miles short of its design range, on August 4. The " Minuteman " solid I.C.B.M. with its great advantages of use either from fixed or railway bases—making a large portion of the American railway network of 250,000 miles a potential launching site—has had promising tests, and is now scheduled for operational capability in 1962, a year in advance of schedule (Fig. 10). With a range of 5500 miles, " Minuteman " is the replacement for " Atlas " and " Titan " I.C.B.M.s, and 600 may be ready for deployment in 1964.[34] The shorter range " Pershing " and the anti-missile " Nike-Zeus," also solid propellant vehicles, have likewise been successful in initial test series during the year. France is endeavouring to produce a large solid I.R.B.M. for the delivery of her own nuclear weapons, when these have been developed, and government-industry collaboration is vested in a joint organisation called SEREB (Société d'Etudes et de Réalisation d'Engins Ballistiques).

Research and development on the American " Skybolt " air-launched ballistic missile was commenced during 1960 (Fig. 11). The Boeing B-52H will carry four " Skybolts," two under each wing, and Britain's V-bombers will be modified to carry the missile, since it is being produced under a U.K.–U.S.A. agreement on co-operative development. " Skybolt's " two stages will have single swivelling nozzles for each of the solid propellant motors, with small rockets for control. The vehicle will probably

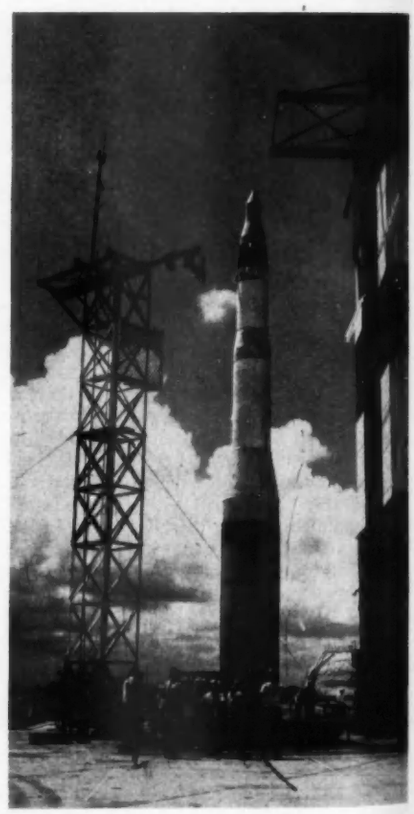


Fig 10—A U.S. Air Force " Minuteman " I.C.B.M. on its launching pad at Cape Canaveral, Florida

* Member, American Rocket Society ; Member of Council, British Interplanetary Society.

be about 30ft long and 3ft in diameter, launched into a 200 or 300 miles' altitude ballistic trajectory from around 45,000ft to a range of about 1000 miles. The inertial

Fig. 11—Test models of "Skybolt" missiles under a B-52 wing mock-up at Boeing Airplane Company's Wichita Division

guidance system will be monitored by a star-tracker to give greater accuracy.[35]

Space Boosters

The vehicles at present in use, in development, or projected for space booster applications are given in approximate order of payload capacity in Table I.

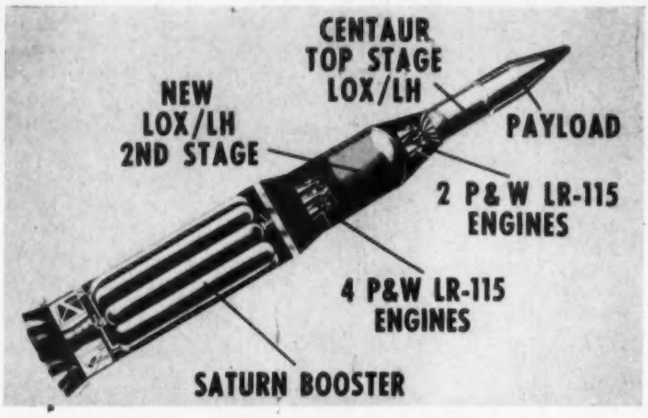
Of these, "Juno 2," "Thor-Able," "Delta" and "Atlas-Able" will be discontinued. Other "Thor" combinations may also be dropped later. This will leave "Scout," "Atlas-Agena" B and "Titan," with "Centaur" and "Saturn" when available, followed by "Nova." "Thor-Agena" B will have a longer life than others whose future is in doubt, for this rocket has been developed—in spite of initial failures—to fair reliability in the "Discoverer" series.

Table I

"Juno" 2*	Modified "Jupiter" IRBM as first stage, plus a number of scaled-down "Sergeant" rockets to make four stages.
"Scout"	Four stages, all solid propellant. First and second modified from "Polaris" and "Sergeant" respectively, third and fourth developed from "Vanguard" upper stages.
"Thor-Able"	Modified "Thor" forms first stage, second is a liquid motor and third a solid, both modified from "Vanguard."
"Thor-Able-Star"†	Two stages only, the second being the "Able-Star" liquid engine with restart capability.
"Delta"*	First stage is a modified "Thor," second is a liquid rocket modified from "Vanguard," and third is a solid motor developed from "Vanguard."
"Thor-Agena"†	Modified "Thor" with "Agena" second stage. "Agena" B is the latest version, having a liquid motor with re-start capability.
"Atlas-Able"*	Modified "Atlas" ICBM, with "Able" forming second and third stages.
"Atlas-Agena" B	"Atlas" IBCM with "Agena" B.
"Titan"	Two-stage liquid propellant ICBM to be used for boosting "Dyna-Soar."
"Centaur"	Modified "Atlas" ICBM, with liquid oxygen-liquid hydrogen second stage. A third stage may be added.
"Saturn"	First version (C-1) will have three liquid propellant stages. C-2 will have four stages.
"Nova"	Presently contemplated version has five stages, but a seven-stage vehicle is also being considered. "Nova" is at the moment a concept rather than a vehicle—it is one of several possible configurations which could use the 1·5 million lb thrust engine in clusters It is planned to use a cluster of six 1·5 million lb thrust engines for the first stage, with liquid oxygen–liquid hydrogen stages for the other four.

* To be discontinued.
† May be discontinued later.

Fig. 12—Diagram of a vehicle boosted by "Saturn"



The capabilities of the remaining boosters are as follows[36]:

Vehicle	Approximate payload weight into close orbit (lb)	Approximate payload for lunar or interplanetary flights (lb)
"Scout"	200	—
"Thor-Agena" B	1,600	—
"Titan" 1	Possibly 5,500*	—
"Atlas-Agena" B	5,800	800
"Centaur"	8,500	1,450
"Titan" 2	Possibly 10,000*	—
"Saturn" C-1	25,000	9,000
"Saturn" C-2	45,000	15,000
"Nova"	—	Possibly up to 200,000

* These are estimates. Only planned for "Dyna-Soar" use at present—no official figures available.

"Saturn" is the largest vehicle currently in development, and represents a major step forward compared with the previous I.C.B.M. class (Fig. 12). The C-1 version will use a cluster of eight liquid oxygen-kerosene motors to give a total thrust of 1,500,000 lb, with a second stage consisting of four Pratt and Whitney LR-115 liquid oxygen–liquid hydrogen engines (instead of two as for "Centaur") with a combined thrust of 80,000 lb, and a modified "Centaur" upper stage as the third with a thrust of 40,000 lb (two LR-115 motors). The later C-2 version will have an additional stage inserted between the first and second, and consisting of four of the 200,000 lb thrust liquid oxygen–liquid hydrogen engines being developed by Rocketdyne; this will increase "Saturn's" payload capabilities by nearly 100 per cent. The "Saturn" C-1, standing about 200ft high, should be ready for flight testing with dummy upper stages by summer 1961.[37]

Unlike "Atlas," the structure of "Saturn" is rigid. Manned payloads such as later and larger versions of the "Dyna-Soar" orbital glider concept would, since they are winged structures, impose severe bending loads on the booster at launch. Rigidity should also make it possible to recover and re-use the booster, or at least some of its systems. "Saturn" has a structural safety factor about 20 per cent above those of other large rockets.[38,39] Recovery involves separation, deceleration, and deployment of a triple parachute. The parachute will trail a 100ft-long line carrying a water-activated switch, which will cause eight small solid retro-rockets in the booster base to be fired and permit a gentle landing on the sea. Work on the first "Saturns" is being carried out at N.A.S.A.'s Marshall Space Flight Centre in Huntsville, Alabama, but industry is now also involved, for Douglas Aircraft Company were recently awarded a 69,000,000 dollar contract for the design, development, fabrication and test of ten "Saturn" vehicles.[40] The N.A.S.A. have also awarded feasibility study contracts to North American Aviation (70,000 dollars) and to Ryan Aeronautical Company (145,000 dollars) for a "paraglider" flexible wing recovery technique for "Saturn."

"Scout's" first firing on July 1 was a failure, for the vehicle was destroyed by ground command when it veered off course. On October 4, however, a "Scout" was sent

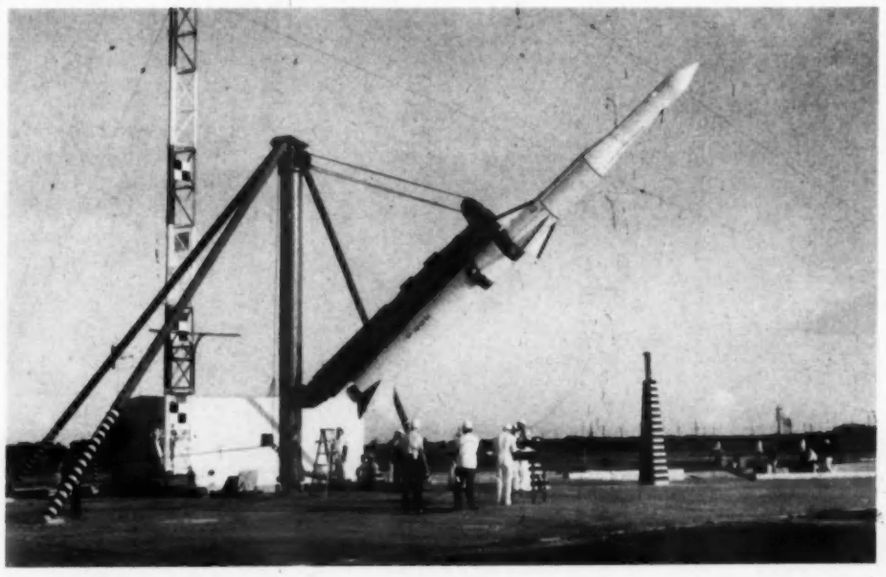


Fig. 13—The U.S. Air Force "Blue Scout Junior" is spin-stabilised by "Hot Seat" rockets mounted tangential to the first stage

in a ballistic trajectory to 3500 miles' altitude, carrying a magnetometer and radiation detectors for measurements in the inner Van Allen belt, and landed in the Atlantic 5800 miles away from the launch base of Wallops Island. Telemetry was received for most of the eighty-minute flight. A principal feature of "Scout" is its cheapness—a production "Scout" costs about 750,000 dollars for the vehicle itself and 900,000 dollars including the launching operation. The cost of buying and launching a "Delta," which has similar payload capabilities, would be about 3·5 million dollars.[36] A launching on December 4 had been intended to carry out drag measurements with a 12ft-diameter inflatable sphere in an orbit between 410 and 1275 miles, but the second stage igniter did not function. The 72ft "Scout" will be used for the joint U.S.–U.K. and U.S.–Canadian satellites.

"Blue Scout Junior" (Fig. 13) is the name given to U.S.A.F.'s own version of "Scout." It is a 40ft four-stage combination, using two of "Scout's" stages plus two others. A "Blue Scout Junior" was launched in September on a ballistic flight, and reached 17,000 miles' altitude with a 32·8 lb payload. Unfortunately the telemetry failed and the radiation data were lost. The U.S.A.F. also have a whole new family of "Scout" variants, designated H.E.T.S. (hyper-environmental test system) 609A, and these are to be used for "Dyna-Soar" model flight tests and such projects as missile-borne communications relay in emergencies. The "Argo" D-8 N.A.S.A. rocket, which was successful in its first flight to 1200 miles altitude with a Project N.E.R.V. (nuclear emulsion recovery vehicle) experiment, is in an intermediate class between "Scout" and "Blue Scout": "Argo" D-8 is a four-stage 62ft rocket, and carried an 83·6 lb package which was recovered after a parachute landing in the sea (Fig. 14).

The initial flight tests of "Centaur," the first vehicle to use liquid oxygen–liquid hydrogen, are expected during 1961 (Fig. 15). The static test vehicle has been installed in Convair's test facility. Like "Atlas," the "Centaur" is made by Convair, and the same thin-gauge, pressurised, stainless steel structure has been used. The second stage will have two Pratt and Whitney LR-115 engines each of 20,000 lb thrust.

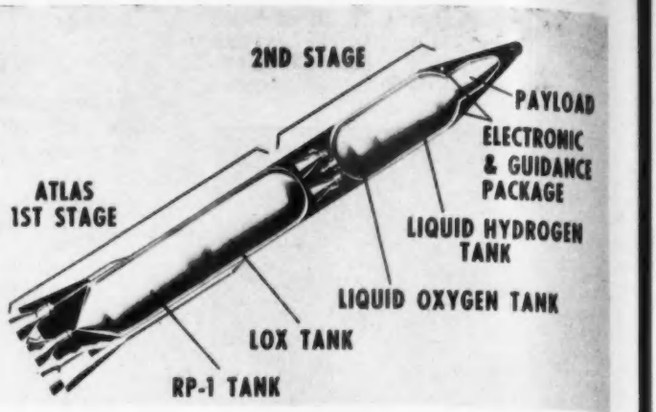


Fig. 15 — Diagram of "Centaur" high-energy vehicle

The overall length of "Centaur" has been given as 107ft 8in. The first flight will be used to monitor the behaviour of the liquid hydrogen propellant: this data should help considerably with further development of hydrogen systems, for sloshing is an outstanding problem. Initial operations are expected in 1962, with an attempt to place a satellite in a twenty-four-hour orbit, and 1963, when a soft lunar landing of N.A.S.A.'s "Surveyor" space vehicle is planned.

The U.S. Navy has a four-stage, all-solid booster called "Caleb" under development. "Caleb" is to be used for air-launching high-altitude probes or small satellites from about 25,000ft using a high-angle launching technique similar to "toss-bombing." It will be 16·5ft long, about 2ft in diameter, and about 3000 lb in weight.

On January 20 and again on January 31, 1960, Russian multi-stage rockets were launched nearly 7800 miles into the Pacific. Subsequently it was announced that no further tests were necessary, and that the next test would be the carrying of a "package of instruments" into outer space for further research. However, further tests were made in July. No details of the rockets are available, but it is believed that they were in fact prototypes of the boosters used for "Sputniks" 4, 5 and 6—the "dummy spaceships," probably with thrusts in the region of 800,000 lb to 1,000,000 lb. It has only just been disclosed that Russia indulged in a remarkable amount of upper atmosphere research rocket activity from ships in the Pacific, having launched as many as twenty-seven rockets during the first half of 1960, and that the firings were carried on even during the tests of the two large booster rockets.[41]

This article does not include a complete review of upper atmosphere research vehicles, although development of cheap rockets for important routine research has continued during 1960. It should be noted that Italy is now entering the field with a joint U.S.–Italian sounding rocket programme. Payloads and technical help will be supplied by N.A.S.A., but Italian rockets will be used, launched from a base in Sardinia, and the data will also be processed by Italy.

The British "Black Knight" re-entry research vehicle programme has continued with successful firings of two-stage versions, the second stage being solid with the same propellant as that used in "Skylark." Heights of 300 miles were achieved, and the last three vehicles carried upper atmosphere experiments. "Black Knight" has established a remarkable reliability record and has been associated with proposals to use "Blue Streak" for British communications satellites.

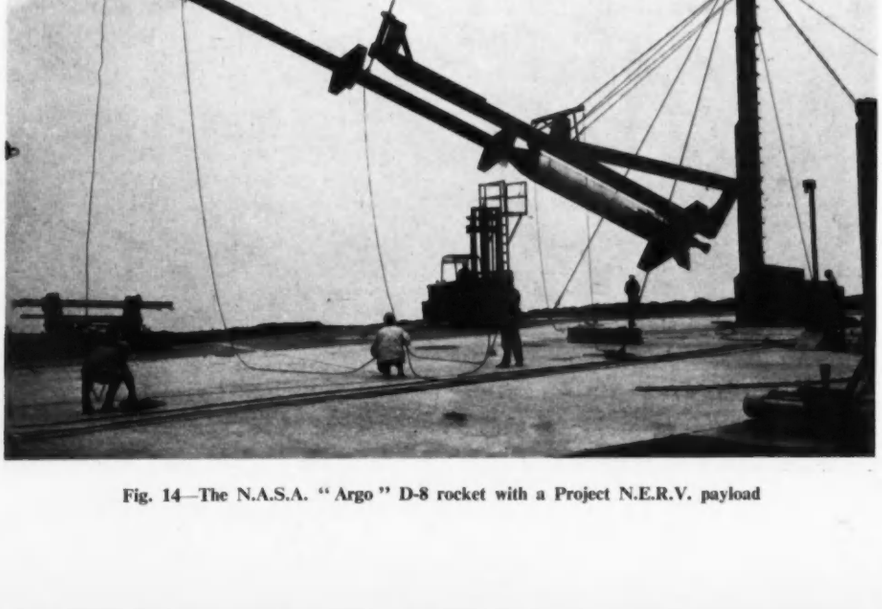


Fig. 14—The N.A.S.A. "Argo" D-8 rocket with a Project N.E.R.V. payload

Space Flight

Various new applications of space flight have been suggested during the year. At the International Astronautical Congress in August, for example, proposals for a Lunar International Laboratory were announced, originated by the newly-formed but unofficial International Academy of Astronautics. The Russians are not members of this body, having suggested that international co-operation in space flight should be arranged through the United Nations. A Soviet scientist has proposed a belt of 1·75 million tons of tiny potassium particles, distributed by rockets in orbits between 1200km and 10,000km, to "greatly improve the thermal system of the northern hemisphere"—but no mention is made of possible effects on the polar ice-cap. A proposal made by Thompson Ramo Wooldridge Corporation involves the spreading of millions of tiny metallic fibres, each about 0·5in long and less than half the thickness of human hair, in a belt several thousand miles above the earth. This would be used for communications relay, but the strong objections of British scientists have been voiced by Sir Bernard Lovell, who believes the project—designated "Needles"—would interfere with radio astronomical research as well as military radar work. On the other hand, the proposers claim the metal whiskers would in effect form tiny dipoles, responding only to a single frequency band and virtually "transparent" to other frequencies.

Continued attention has also been given

to such concepts as PROFAC, the Propulsive Fluid Accumulator, which would gather and liquefy particles of air during orbit, thus providing an orbital re-fuelling station for chemically propelled vehicles. Like many other similar proposals, the practical use as well as the practical accomplishment of PROFAC is in some doubt.

Leaving such " outer fringe " schemes to the controversy they will undoubtedly arouse, we now turn to the events and successful launchings of 1960, which are considerable, and to official programmes more soundly based on technical feasibility.

As a preface to the following section, however, it may be noted that the Harvard Business Review recently conducted a survey of some 2000 business and professional men's opinions on space programmes, and that the N.A.S.A. have commissioned the Brookings Institution to survey the effects of peaceful space activity on human affairs. The Brookings Institution study should show which areas of space flight activity are likely to bring the most social and economic benefits. The majority of respondents to the Harvard Business Review questionnaire strongly supported a vigorous American space programme, listing their reasons for space research in the order : pure science ; military and political control of space ; tangible economic returns ; and prestige vis-à-vis the Soviet Union. In the Eastern hemisphere, Vladimir V. Dobronravov has answered arguments that space costs are delaying Russian economic progress by saying that space research would give good returns in weather forecasting, improved communications, nuclear energy applications, and further developments in automation, instruments, electronics, biology and medicine. He also emphasised that the space programme's " enormous political and international significance " must not be overlooked, a reminder that the prestige motive is related to political and economic factors.

Satellites—British Prospects

When " Blue Streak " was cancelled as a weapon, there was considerable doubt as to whether it would be financed as a space vehicle launcher. The Government has just kept the project ticking over during the subsequent period of consideration and discussion. There have been submissions on the economic value of a British communication satellite system, launched by " Blue Streak " and " Black Knight " in combination. This project was first put forward at the Commonwealth Spaceflight Symposium in 1959, when it was argued that a co-operative Commonwealth spaceflight programme should be worked out. Official discussions have been held with other interested members of the Commonwealth, especially Australia. Much more recently, these were extended to other European governments, leading to the formation on December 1, 1960, of a preparatory commission for a European space research organisation, in which eleven nations joined : Britain, France, West Germany, Belgium, Holland, Denmark, Norway, Sweden, Italy, Switzerland and Spain. West Germany has also set up a Committee for Space Research, consisting mostly of university representatives, responsible to the Aeronautical Advisory Board of the Federal Ministry of Transport. In February, 1961, the formation of the British Space Development Company, Ltd. was announced, with eight companies—including de Havilland, Rolls-Royce, and A.E.I.—participating in the venture, initial capital being £20,000. The aims of this new company may be broadly stated as co-operation with the Government in the exploitation of space flight.

Meanwhile, a British fact-finding team led by Major-General L. de M. Thuillier had visited the U.S.A. to gather data on communication satellites. Major-General Thuillier said on his return that it would probably be fifteen to twenty years before a reliable one could be placed in orbit for commercial use. On this time scale, there appeared to be room for British participation. A meeting of the All-Party Space Research Committee, organised by the British Interplanetary Society, was held in the House of Commons on December 1 to consider communication satellites. Industrial representatives included speakers from Hawker Siddeley Aviation, Ltd., Pye Telecommunications, Ltd., E.M.I., and Decca Radar, Ltd. A study made by de Havilland Aircraft Company involving eight active relay satellites to give global service was detailed. The satellites would weigh 400 lb to 700 lb, and be capable of launching by " Blue Streak "/" Black Knight." Costs of such a communication satellite programme were estimated at a total of £70,000,000 over twenty years, allowing £1,000,000 for each satellite and the same for each of twenty-four ground stations throughout the Commonwealth, and a sum for possible launch failures or replacements of satellites. The maintenance of ground stations over this period was estimated separately at £173 million.

The Advanced Projects Group of Hawker Siddeley Aviation are also concerned with a communication satellite study[42]. Dr. W. F. Hilton and S. R. Dauncey, both of the Advanced Projects Group, gave a paper entitled " Communications Satellite Orbits " at the Eleventh International Astronautical Federation at Stockholm in August. In this paper they introduced the interesting concept of elliptic orbits at 63 deg. to the equator, and their detailed study shows that adequate world coverage could be provided with very few satellites. Other orbits, including twenty-four hour " stationary " orbits, are also considered, but the consideration of the " 63 deg. slot " is due to the fact that the latitude of the apogee remains constant when orbits at 63·4 deg. inclination to the equator are employed.

Of all the possible commercial applications of satellites, this is the one which offers the best prospects of eventual profit. In the House of Commons on December 21, the whole question of a British or European communication satellite programme was debated. Mr. David Price (Conservative member for Eastleigh) said that de Havilland's system would make it possible to reduce the cost of transatlantic telephone calls from £1 per minute to 6d. per minute. The profit figures, he pointed out, showed a return of over £450 million over twenty years on an outlay of roughly £300 million, which was good profit, even for a government. Mr. Geoffrey Rippon, Parliamentary Secretary to the Ministry of Aviation, said that Post Office and Ministry scientists and engineers were already making a joint study of the design of ground stations and satellites, as well as overall system design, and industry would be called in at the appropriate stage.

Mr. Rippon reported that the most promising system was one of active satellites, carrying radio receivers and transmitters which receive, amplify and transmit signals. On the technical side, it had been established that it was practicable to develop a satellite launcher using a first stage formed from " Blue Streak " with a second stage based on French development work. This news, though very encouraging as far as " Blue Streak " is concerned, has been greeted with mixed feelings—for " Black Knight " is a very promising rocket, already in an advanced stage of development, and is apparently in danger of being passed over in favour of a French second stage. However, plans have not been finally decided and the British and French governments propose to hold joint conferences of interested countries during 1961.

In spite of these strong signs and portents, the annual report of the Commonwealth Telecommunications Board revealed an £80,000,000 project for a global system of large capacity cables to meet the future needs of the Commonwealth. Mr. Rippon remarked in the House debate, however, that the only approved parts of this programme were a new transatlantic cable in 1961 and a cable between Canada and Australia in 1964, at a total cost of between £35,000,000 and £40,000,000, and the U.K. share would be less than this. These cables are apparently necessary to provide for Commonwealth communication needs until reliable satellites are achieved. Quite apart from the difficulty of designing reliable electronic equipment and power supplies, the effects of cosmic radiation and micrometeorites on electronic components—especially transistors—have not yet been fully explored. In any event, with world communications increasing rapidly, it seems likely that cable systems and communication satellites will be complementary rather than competitive.

The United Kingdom now has the most extensive space programme of any European or Commonwealth country, and an outline was given to the Council of Europe in September by Mr. David Price,[43] assisted by the British Interplanetary Society. A paper was also given before the Royal Aeronautical Society on November 23 by M. O. Robins on " The British Space Research Programme." The N.A.S.A. name of the U.S.–U.K. satellite due to be launched by a " Scout " from Wallops Island, Virginia, late in 1961, has been given as " Ionosphere Satellite S-51," having previously been called " International 1 "—but the British name is " U.K. Scout 1." This satellite will be mainly concerned with ionosphere measurements, but will also carry solar and cosmic radiation instruments.

The design of " U.K. Scout 1 " was agreed in November. The satellite will be a 23in diameter sphere, with four solar cell paddles having a total area of about 6ft. Two extending arms will carry instruments to measure electron densities and temperatures, and four telemetry antennae will be used. The upper part of the sphere will hold instruments to measure ion mass and cosmic radiation—both of these are Imperial College experiments. The sphere will also contain three solar radiation sensors and two X-ray counters. The proposed orbit has a perigee of 200 miles and an apogee of 600 miles, with an inclination to the equator of 55 deg. Fig. 16 gives an impression of the satellite's probable appearance.

The British instrument package of about 20 lb weight is being prepared mainly by various universities, but Bristol Aircraft, Ltd. is making the X-ray spectrometer. Professor Sir Harrie Massey, Chairman of the British National Committee on Space Research, has said that on some transits of the satellite its path will be followed by an aircraft making parallel cosmic-ray measurements, thus determining from a comparison

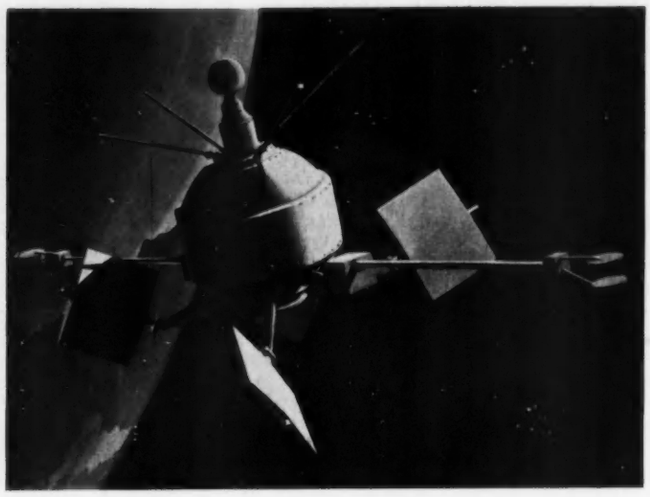


Fig. 16 (Left)—Satellite S-51 : the payload of this vehicle is being developed in the United Kingdom. Fig. 17 (Right)—" Transit " 1B navigational satellite on " Thor "-" Ablestar " launching vehicle ; one half of the fairing protecting the satellite during passage through the atmosphere is in place

of data the screening effect of the atmosphere. Experiments are already being planned for the second " Scout "-launched satellite, which may be launched into a polar orbit from the Pacific Missile Range in 1962. The Meteorological Office want ozone measurements in the upper atmosphere, Belfast University want a micrometeorite experiment, and Jodrell Bank scientists wish to incorporate a lightweight type of radio telescope to measure long wave signals from deep space which do not penetrate the atmosphere—this would require trailing aerials of about 200ft in length. Sir Bernard Lovell has previously requested the Russians to include a Jodrell Bank-designed radio telescope in one of their satellites, having been informed by the N.A.S.A. that there was no hope of inclusion in American satellites for some years to come, but no arrangement resulted.

The U.S.–Canadian satellite is also planned for launching into orbit towards the end of 1961. The satellite will carry radar transmitters to probe the ionosphere from the upper side, being in a polar orbit of about 700 miles apogee, and receivers to study galactic noise. A transmission life of about one year is expected, using solar cells and batteries.

American Communication Satellites

The N.A.S.A. has promised to give financial support to technically promising industrial proposals for communication satellites, which are believed better left to private enterprise. The American Telephone and Telegraph Company put forward a proposal in October which involved a number of polar-orbiting active relay satellites of 175 lb weight, the first to be launched within a year. Finance by the Company in co-operation with telephone services abroad was envisaged. Hughes Aircraft Company have also proposed an active satellite, and according to the figures released it is of exceptionally small size and weight. The whole electronics package is said to weigh 6·5 lb, total satellite weight (structure and 2700 solar cells for power supplies) being 32 lb. Each Hughes satellite could relay up to 600 two-wire telephone messages simultaneously. A modified "Scout" would be used to send the satellite into a stationary orbit at about 22,500 miles.[44] The possibility of using nuclear-powered satellites in stationary orbits to relay television broadcasts has been considered by the Atomic Energy Commission, who have said that the 3kW SNAP-2 could furnish enough power for up to two channels covering the whole of the U.S.A., while SNAP-8 with 35kW would provide up to ten channels for the U.S.A. or two channels for the Western hemisphere.

The " Echo 1 " passive communication satellite, launched on August 12, is a 100ft-diameter sphere which was inflated in orbit. The first message reflected by it was a message from President Eisenhower inviting other nations to use the sphere for similar experiments. In early November it was used for the first " space mail," between Washington and Newark, N.J.: the traditional Christmas message for the U.S. Post Office, " Shop and mail early," was transmitted, reflected by the sphere, and received, using a facsimile transmitter and receiver system capable of handling up to fifty letters simultaneously, in a period of three minutes. The shape of " Echo 1's " orbit is being changed by solar radiation pressure. The inflatable sphere of aluminised " Mylar " plastic film was folded in a 26·5in-diameter magnesium sphere, injected into a nearly circular orbit by the " Delta " —the precision of injection was due to the specially-developed flight controller in the " Delta " rocket.[49] The magnesium container was separated into its two halves by a small explosive charge, and the satellite was then inflated to 100ft in diameter by the sublimation of 10 lb of benzoic acid and 20 lb of anthraquinone together with the expansion of any remaining air. Micrometeorites were the worst hazards expected, and the N.A.S.A. have estimated that the normal increase in puncture area is 1·4 square inches per day—but it is believed that this increased to about 8·4 square inch per day during the annual shower of micrometeorites which was at its height in August. One of the aims of the experiment was to test the ability of such inflatable structures to withstand the space environment. Another hazard, expected when " Echo " began to go into the Earth's shadow—reaching a maximum " shaded " period of thirty minutes in December—was the solidification of the gases, resulting in loss of spherical shape. However, the sphere carries two tracking beacons which depend on the shape of the satellite for their ability to transmit, and as these were still transmitting in December, there is no evidence that " Echo's " shape has been altered to any appreciable extent. Not only has a large number of communications experiments been conducted with " Echo 1," but it has also been used to acquire data concerning ionospheric effects on radio signals.

N.A.S.A. figures show that twenty-six " Echo " spheres would have to be placed in 3000- to 4000-mile orbits in order to give 99 per cent availability for communications relay. The N.A.S.A. plans to continue the promising passive reflector studies, but also intends to demonstrate as soon as possible the technical feasibility of small active relay satellites in orbits between 3000 and 5600 miles. One scheme for 1963 or 1964, Project " Rebound," involves using " Centaur " to orbit up to ten lightweight, active satellites at one launch. A more advanced passive design with directional reflecting properties is being considered. The relatively cheap and inherently reliable passive reflector satellite offers prospects of a reasonably effective communications system to serve at least during the development period of active satellites.

However, a military communication satellite of an active type is already in orbit and is working well, following on the success of the Project " Score " (Signals Communications Orbital Relay Experiment) relay satellite over a year previously. After a launch failure with " Courier 1A " on August 18, the U.S. Army " Courier 1B " was successfully launched on October 4, containing 300 lb of instruments, including five high-speed magnetic tape recorders and radio equipment. Power is provided by solar cells and batteries, and the 500 lb satellite is expected to remain operational for about a year—but will stay in orbit for much longer. " Courier " receives and records high-speed radio-teletype or voice messages and transmits them to another station when interrogated by a coded signal. The equipment is capable of sending and receiving about 68,000 words a minute simultaneously. A series of " Courier "-type satellites may be placed in orbit within four years, giving the West a communications system which is difficult to jam. " Advent " or " Comsat " are the names given to an advanced version for twenty-four hour equatorial orbits. This version will be about 1000 lb weight with 400 voice channels, and the first may be placed in orbit in 1963 by a " Centaur " rocket.

Other American Satellites

These other applications of satellites may be divided into four groups : navigation, meteorological, reconnaissance, and research. Meteorological and the " Samos "-type reconnaisance satellites have, however, been considered together as " observation satellites "

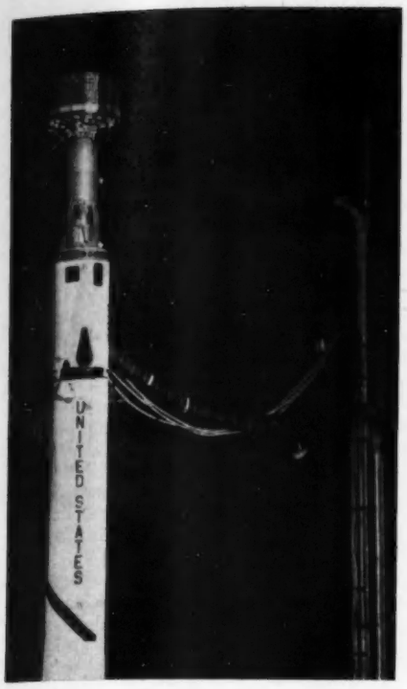


Fig. 18—" Tiros " II weather observation satellite in course of assembly to launching vehicle

in Reference 45, which examines their present and potential capabilities.

Navigation.—" Transit 1B " and " Transit 2A " navigation satellites were successfully placed in orbit during the year. " 1B " was designed to demonstrate the feasibility of the system, and carried four transmitters, two receivers, two telemetering receivers and transmitters, an infra-red scanner to measure rotation rate, two very stable oscillators protected from temperature effects by Dewar flasks, and chemical batteries charged by solar cells (Fig. 17). Both the satellites are spin-stabilised. Further, both achieved extra " firsts," for the launching of " 1B " was the first time a rocket had been shut down and re-started in space (" Able-Star "), and " 2A " carried a " piggy-back " research satellite—the first time two satellites have been placed in orbit by one rocket.

" Transit 2A " is powered entirely by a broad equatorial belt of solar cells, and in place of the chemical batteries and equipment of " 1B " it carries an electronic digital clock to provide transmission of a very accurate time standard, and a Canadian receiver to measure galactic noise. Spin stabilisation is designed to ensure that the antennae remain directed towards Earth, and the orbit is nearly circular. The " piggy-back " satellite was designed by the U.S. Naval Research Laboratory, and contains instruments to measure solar radiation. It was separated from " Transit 2A " by a spring mechanism, and now slightly precedes the navigation satellite in orbit. Both " Transit 2A " and the N.R.L. satellites are working well. A further attempt to launch a double satellite—" Transit 3A "—failed on November 30.

Meteorological.—As part of a N.A.S.A. study contract, the Rand Corporation has prepared a report on economic aspects of using weather data from satellites. Provided the data can be processed, analysed and passed on quickly, more accurate forecasting should facilitate better planning, e.g. of crops, and early storm warnings should save lives. Tornadoes at present cost the U.S.A. about 14,000,000 dollars a year, and 230 lives a year. Rand Corporation studies are now being made of the economic effects of hurricanes, and the possible improvements in air freight operations which better forecasting may bring.

" Tiros 1," the first Television Infra-Red Observation Satellite, has already shown that various types of storms such as tornadoes and hurricanes may be identified by their particular cloud vortex shapes. A first task in stepping up the speed of analysing data is to be the production of a guide to these special vortex shapes. The satellite carries two miniature T.V. cameras, each with a tape recorder for storage of data, but this may also be transmitted directly if desired ; and two tracking beacons, power being supplied by nickel-cadmium batteries charged by 9200 solar cells covering the top and sides of the " pillbox " structure.

One of the cameras is wide-angle and the other narrow. A major problem was to stabilise the satellites by relatively simple means, namely spin-stabilisation, so that the cameras would constantly point towards the Earth's surface, but to ensure that the spin rate would be sufficiently low for shutter operation to cancel out the effects of movement on the pictures obtained. Another problem was the possibility of precession of the spin axis. " Tiros 1 " is stabilised at 12 r.p.m., and carries equipment for reporting the spin-axis attitude to ground command, thus allowing pictures to be taken on command at the most favourable times, and this equipment is also used to provide position-reference information for each picture. Since the spin of the satellite, as it leaves the final stage of the booster, is too high, it is slowed down by releasing two weights on light cables from diametrically

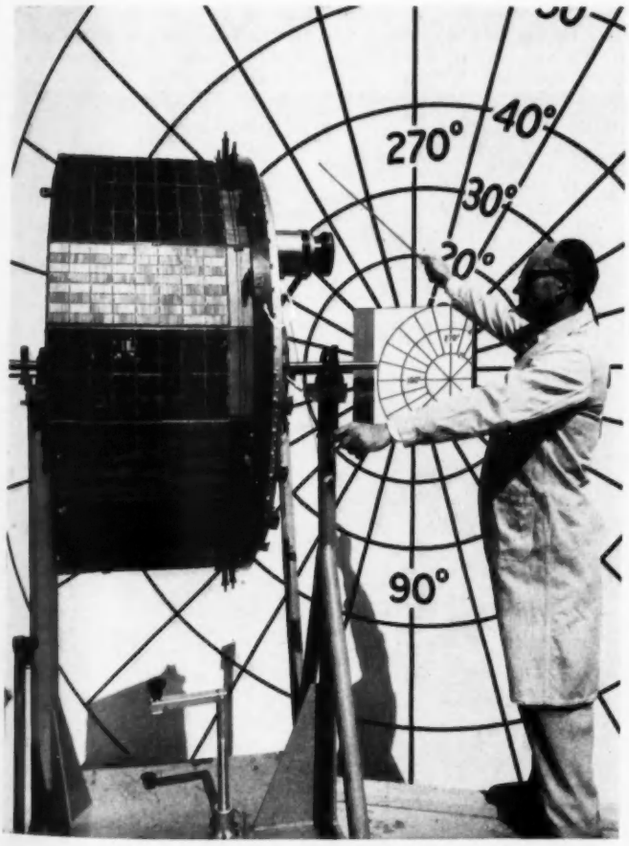


Fig. 19 (Left)—The " Tiros " II satellite positioned for calibration of focus and field of view of its two cameras. The lens of the wide angle camera protrudes from the baseplate of the satellite at the upper right. Through the opening in the centre of the large calibration scale appears a second one used for measurements on the satellite's narrow angle camera. Fig. 20 (Right)—Mounted inside a spherical cage designed to produce magnetic fields resembling those of the earth, the " Tiros " II weather observation satellite is shown as it was prepared for tests of its magnetic stabilisation system

opposed positions on the base (" Yo-Yo " system). The spin is liable to slow down owing to eddy current drag caused by interaction with the Earth's magnetic field—an effect which was later turned to good account in the stabilisation system of " Tiros 2 "—and spin decay is prevented by four very small rockets each of about 1·5 lb thrust mounted on the base. These rockets may be fired in diametric pairs to give impetus in the direction of the spin. Some means of damping precession was also necessary, in order to line up the optical and spin axes, and alignment to $\pm 0{\cdot}5$ deg. is achieved by a system called " Team " : this employs two masses which travel on rails in line with the spin axis, these masses being positioned at diametrically opposite points against the outer structure. The Yo-Yo and Team systems have both proved satisfactory in practice. Another necessity is accurate timing, required for synchronisation of camera sweep, control of tape recorder speed, and control of camera operation at the appropriate point in each orbit. A new magnetic system with the trade-name " Increamag " was used, and the " Tiros 1 " clock and sequence timer are accurate to at least one second per hour. During its working life of 2½ months (up to June 17), " Tiros 1 " made 1302 orbits and produced over 22,000 cloud cover pictures, some of which are very good.[46, 47, 48]

The second " Tiros " was launched in November to continue the work (Figs. 18, 19, 20). " Tiros 2 " went into a higher orbit than was planned (380 miles), but a remarkably circular one—apogee 435 miles, perigee 415 miles. The precise orbital injection of the " Tiros " satellites is largely due to the flight controller used in the " Delta " rocket.[49] In addition to similar equipment to that of the first weather satellite, " Tiros 2 " carries seven infra-red sensors to measure radiation reflected from Earth. " Tiros 2's " orbit makes it capable of mapping cloud formation 3600 miles north and south of the equator. Since this area includes parts of Russia and China, the N.A.S.A. have made it quite clear that the pictures obtained are not sufficiently definitive of ground features to give them any reconnaissance value.

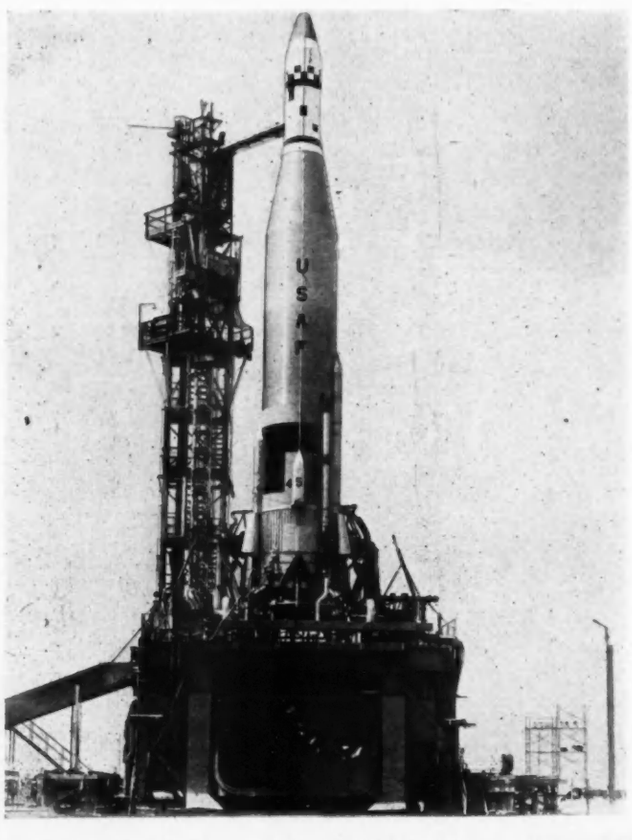
" Tiros 1 " and " 2 " are both experimental—they will be followed by " Nimbus " satellites, planned for launching during 1962 and 1963, and later by " Aeros." The latter is a provisional code name for a proposed weather satellite in a twenty-four-hour stationary orbit which may be launched in 1964, and three such vehicles could provide continuous observation of almost the entire globe. " Nimbus " will consist of the whole final stage of the launching rocket, weighing about 650 lb, and will have an improved means of stabilisation, employing an inertia wheel, to keep the cameras pointed towards Earth. Later types of " Nimbus " may carry a form of radar to detect precipitation, and instruments for measuring temperatures, in addition to cameras and sensors.

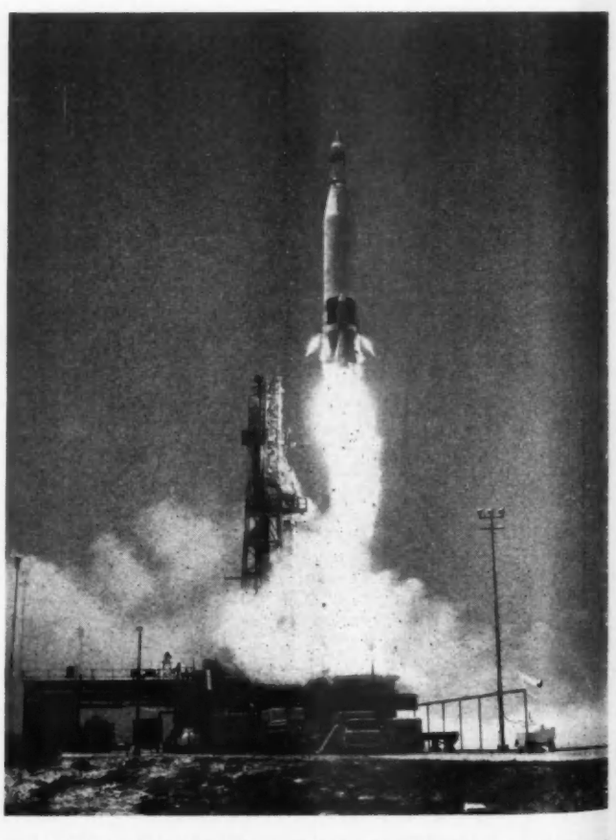
Reconnaissance.—The " SAMOS " project is specifically designed for reconnaissance, as its full name shows : Surveillance and Missile Observation Satellite. The present E-5 version of " Samos " was developed by Lockheed from the " Discoverer " satellite, recovery of a 300 lb instrument capsule being effected by separation and retro-rocket in the same way as " Discoverer." Early difficulties with the " Discoverer " programme held up " Samos," but now the recovery methods have been proved feasible the " Samos " project is expected to go ahead. The first launching of a " Samos " vehicle by an " Atlas-Agena " B rocket was a failure owing to malfunction of the " Agena " B but a second attempt made on January 31, 1961, was successful. The U.S.A.F. have asked the Martin Company, General Electric's Missile and Space Vehicle Department, and Eastman Kodak to develop the later E-6 version, which will weigh up to 3000 lb and will contain smaller capsules capable of being returned to Earth either on command or according to a pre-arranged programme. " Samos " is expected to be operational by the end of 1962.

Avco Research Laboratory have been awarded a U.S.A.F. contract for a drag-brake recoverable satellite. The vehicle is designed to unfold a rigid, umbrella-like structure giving high drag to minimise re-entry speed and radiate much of the heat developed during re-entry. The configuration will be similar to that proposed by Avco several years ago for manned applications, and it is not yet clear whether this satellite is to be part of the " Samos " programme or a follow-up to the " Mercury " manned orbital capsule project.

Experimental launchings in the " MIDAS " programme (Missile Defence Alarm System) preceded the " Samos " attempt, but with no more success, for " Midas 1 " failed on February 26 owing to a fault in the " Atlas-Agena " booster, and " Midas 2 "—though duly placed in orbit on May 24—suffered a telemetry failure after the sixteenth orbit (Figs. 21, 22). The main purpose of " Midas 2 " had been to obtain an infra-red picture of Earth from an altitude of 300 miles, while the purposes of the programme as a whole are to detect the launching of ballistic missiles by means of infra-red sensors and to report such launchings by radio.

Research.—The " Discoverer " series forms the largest part of the research group of satellites, but " Discoverer " is really a multi-purpose vehicle. The general purposes of the programme are to gather data on propulsion, communications, orbital performance and stabilisation, and methods of recovery, and the " Mercury " man-in-space project. Each vehicle in the series was planned to make a pre-determined number of





Figs. 21 and 22—The " Agena " forming " Midas 2," a surveillance satellite, seen on its " Atlas " booster before and during launching from Cape Canaveral

close orbits of the " Agena " second stage to gather data, and then to eject an instrument capsule containing the recorded data.

Some details of the " Discoverer " recovery technique were given at the International Astronautical Congress in Stockholm. After gathering data, usually for sixteen orbits, the satellite is positioned for ejection of the capsule for re-entry on the seventeenth pass. The satellite timer is corrected by ground signals, to ensure accuracy for the ejection procedure, which consists of separation of the capsule from " Agena " by explosive bolts and immediately spin-stabilising the capsule with two small rockets, and firing the retro-rocket to cause the capsule to re-enter on a curved path from orbit. Ejection and retro-rocket firing take place in the region of the North Pole, but the hottest period of re-entry—when the nose-cone surfaces ablate—occurs north of Hawaii, and the satellite is decelerated from about 18,000 m.p.h. to less than Mach 1 in the short space of about five minutes. The curved path then becomes nearly vertical, a parachute is opened at 50,000ft to slow the capsule to about 35 m.p.h., and the flashing lights, radio beacon and radar chaff which the capsule carries are used to aid recovery. Patrolling C-119 Fairchild aircraft use trailing nets to attempt recovery in mid-air. Should the capsule land in the sea, however, it also carries a dye-marker to stain the water.

" Discoverers 9 " to " 19 " were launched between February and December, 1960, and " 13," " 14," " 17 " and " 18 " were successful, the instrument capsules being duly ejected and recovered once from the sea ("13") and three times in mid-air by aircraft. " Discoverer 17 " provided some of the most useful data, firstly because it successfully tested the " Agena " B, and secondly owing to its orbits with solar radiation instrumentation at a time when intense sunspot activity was occurring. The " Discoverer 18 " capsule contained biological experiments, including human skin, bone marrow and blood cells, plant spores and algae, for studies of radiation effects on living cells. Various metals were used to encase the specimens and test their shielding properties. Results indicate that aluminium may be better than lead for this purpose, for the specimens enclosed in aluminium were less affected by radiation than the others—this is attributed to the greatly reduced secondary emission effects possible with metals like aluminium. " Discoverer 19 " was sent into polar orbit on December 20, but carried infra-red sensors, in place of the usual capsule, to measure the wavelength and intensity of infra-red radiation from Earth. The equipment is similar to that used (also experimentally) in " Tiros 2," and to that which is projected for " Midas " satellites for I.C.B.M. detection. Unfortunately, transmission of data from " Discoverer 19 " ceased on December 25. Another fifteen " Discoverer " launchings are planned.

These recent successes are the result of long and patient development. The tracking of the first " Discoverer " (February 28, 1959) was hindered by the tumbling motion of the satellite, but no separate instrument capsule was carried on that occasion. Later " Discoverers " carried stabilisation equipment to prevent tumbling, which would have caused considerable difficulties in the ejection, re-entry and recovery of capsules.

" Explorer 8," placed in orbit by a " Juno-2 " rocket on November 3, is a 90 lb satellite equipped to measure the concentration and speed of ionospheric particles. It is spin-stabilised and achieved the elliptic orbit necessary for the success of the experiments. An attempt to launch an earlier " Explorer " into a more highly elliptic orbit had failed on March 23—an apogee of 33,000 miles and a perigee of 200 miles, for wide coverage of sections of the radiation belts, had been intended. The " Explorer 8 " satellite is believed to have suffered battery failure, for it ceased transmitting on December 27.

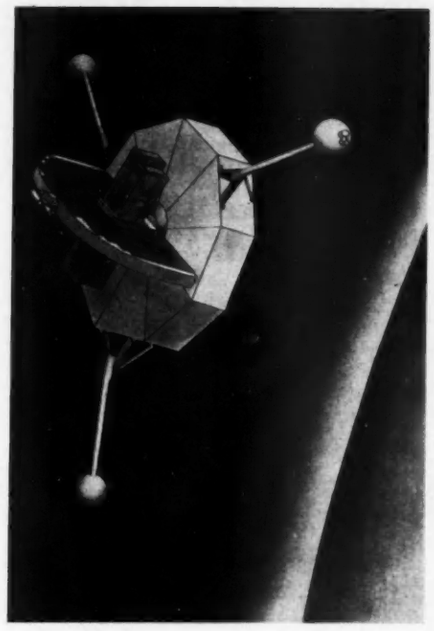


Fig. 23—The O.S.O.—Orbiting Solar Observatory—will have a mass of 350 lb. It will be stabilised with respect to the sun by the gas jets seen on the three arms

The N.A.S.A. have announced plans for large orbiting observatories. The O.A.O. or Orbiting Astronomical Observatory, weighing about 3200 lb, is expected to be placed in a 500-mile circular orbit in late 1963, and two observatory vehicles have been ordered from Grumman Aircraft. The first one will have a 36in reflecting mirror, and will be octagonal, 9·5ft high, 6·5ft in diameter, equipped with two solar cell " paddles " to give 350W. The satellite is a step towards standardised design by the N.A.S.A., for the basic structure and auxiliary equipment is also to be used for a series of Orbiting Geophysical Observatories. The standardised shell structure will contain power supplies, stabilisation, control and telemetry equipment adaptable for use with instrument packages of up to 1000 lb weight. The O.A.O. satellites are intended to measure X-ray, ultra-violet and infra-red radiation from space, and various experiments have been suggested by American observatories, universities and research organisations .

The O.G.O. series of three geophysical observatories is to be supplied by Space Technology Laboratories to N.A.S.A. within the next three years. Although O.A.O. was planned first, one of the O.G.O. vehicles is likely to be the first standardised satellite in orbit : this will be called E.G.O., concerned with the study of energetic particles, and will be launched by an " Atlas-Agena " B into a highly elliptical orbit with an apogee of about 70,000 miles by mid-1963. This will be followed by P.O.G.O.—Polar Orbiting G.O.—with a less eccentric orbit. Further O.G.O. satellite experiments may include the mapping of magnetic fields, atmospheric and ionospheric structure, and meteorological or biological experiments.

The earliest project of all, however, is O.S.O.—the 350 lb Orbiting Solar Observatory—which may be launched during 1961 by a " Thor-Delta " rocket (Fig. 23). Equipment may include a photon counter for X-ray measurement, grazing and normal incidence spectrographs, three television cameras, telemetry, and a solar-seeking servomechanism to keep the instruments pointed towards the sun. The satellite will be spin-stabilised with respect to the sun, using a flywheel and small rockets or gas jets. The three cameras will probably be used for photographing the sun in the visible spectrum, in Lyman-alpha radiation, and in infra-red.

A geodetic satellite project was originally in the hands of the N.A.S.A. This vehicle is to map variations in Earth's gravitational field, determine Earth's shape more accurately, ascertain the gravitational centre between Earth and Moon, and analyse the mass of the Moon. The U.S. Department of Defense has now taken over responsibility for the satellite, which may be called " Firefly," because the N.A.S.A. declared that they could only handle this project if the data were made available to the rest of the world.

Other projects are " Saint " and " Arents." The U.S.A.F. " Saint," on which research and development are in progress by R.C.A. and others with a total contract value of about 60,000,000 dollars, is planned to be a satellite capable of identifying, and if necessary intercepting, other satellites. " Arents " is an Advanced Research Projects Agency plan for a satellite capable of investigating space in orbits of about 22,000 miles, and three vehicles are being built by Convair.

Russian Satellites

" Sputnik 3 " finally re-entered and burned up on April 6, 1960. This 2982 lb satellite, launched on May 15, 1958, has provided much information on conditions in near space. The radio equipment, powered by solar cells when the chemical batteries ceased to function, has continued to transmit during the whole life of the satellite. At the beginning of 1960, 8600 Earth orbits had been made, representing a total distance of more than 239 million miles.

Following the success of Russia's new high-powered rockets in the January tests, using the Pacific as target area, the U.S.S.R. have placed in orbit a series of three satellites each weighing more than 10,000 lb. These have been called " dummy spaceships," after Soviet English language broadcasts said the first vehicle carried " a dummy astronaut." Broadcasts in Russian, however, said the vehicle carried " a load equivalent to the weight of a human being."

These satellites, launched in May, August and December, are very similar in design and instrumentation. All three contained model space cabins, the purposes of which were to test life support systems and separation of the space cabin from the instrument compartment by ground radio command. The first, " Sputnik 4," merely tested feasibility, and both cabin and instrument compartment had been designed to burn up on re-entry, following separation. Unfortunately, the satellite was badly oriented at the time ground command signalled braking and separation, retro-rocket thrust was applied in the wrong direction, and the whole satellite was sent into a higher orbit. However, telemetry had already shown normal functioning of the cabin conditioning systems during flight.

" Sputnik 5 " carried two dogs, " Belka " and " Strelka," mice, seeds, bacteria, and specimens of human skin. The dogs and a dozen of the mice were in an escape capsule inside the space cabin, while the others were

in the cabin. A successful live recovery was achieved, using retro-rocket and parachute, and the vehicle landed within six miles of the expected point. Television pictures of the dogs were transmitted in flight—this was the first use of live T.V. broadcasts from orbit.

The third vehicle, " Sputnik 6," also carried two dogs—" Pchelka " and " Mushka." This vehicle went into a low orbit, far too close to the atmosphere. When ground command signalled deceleration and separation, re-entry was made too sharply, and the ship burned up.

Two points emerge from this : the total weight, over 10,000 lb, placed in orbit ; and the successful recovery of " Sputnik 5." These do not in themselves indicate that the Russians are ahead of the U.S.A. in any significant technical sense other than the power of the booster used. The Americans have made several, not just one, recovery from orbit. They have also sent mice on a ballistic flight into space for a distance of 700 miles (October 13, 1960) in an " Atlas " nose cone, and recovered them alive—this is the furthest distance any animal has been sent into space and recovered alive. The instrumentation of such a vehicle is well within the existing state-of-the-art in America. The failure of " Sputnik 6 " has been treated very reticently by the Russians, and is evidently a set-back, showing that a longer development time is necessary to bring greater reliability before manned flight can be attempted.

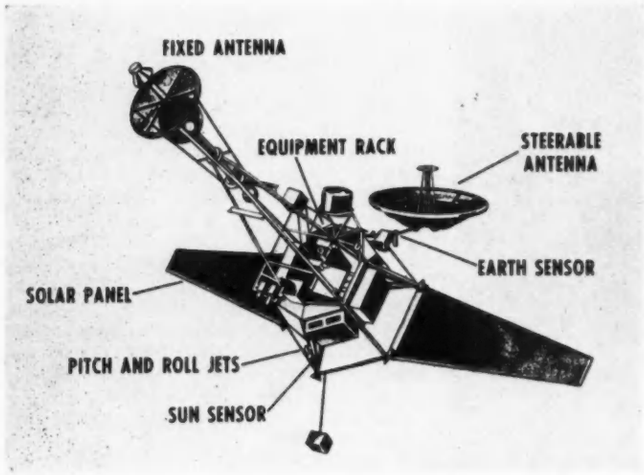


Fig. 24 — Diagram of vehicle for " Ranger " and " Mariner " projects

Lunar and Interplanetary Probes

The American " Pioneer 5 " artificial solar satellite has provided a considerable amount of data since its launching in March, 1960. The aims were to test long-range communication, and to collect data on cosmic radiation, solar plasmas, magnetic fields, micrometeorites, temperature changes, &c., probing space between the orbits of Earth and Venus. Tracking the vehicle provided a new means of measuring the astronomical unit by triangulation of the signal plots. The power supply is provided by four paddle-shaped vanes of solar cells charging twenty-eight nickel-cadmium batteries. The 150W transmitter was commanded for the first time on May 8 from Jodrell Bank, but transmission power was limited, apparently due to deterioration of the chemical batteries.

Initially, a 5W transmitter was operated, and the 150W transmitter was later turned on from a distance of about 8,000,000 miles. When Jodrell Bank lost contact on June 26, " Pioneer 5 " was over 22,000,000 miles away and had been transmitting data for nearly 140 hours. The data was particularly useful because of the intense solar activity which occurred during late March and early April. Important information on magnetic fields was also obtained. " Pioneer 5 " is now moving ahead of the Earth, being affected by solar gravitation, and will not return to this vicinity until 1989.

" Pioneer 6 " failed on September 25, 1959, when an " Atlas " blew up on the pad, on November 26, 1959, and September 25, 1960, when the launch vehicles (" Atlas-Able ") failed in flight. The fourth and last attempt was made on December 14, 1960, when the booster again failed at launch. It had been intended to go into lunar orbit, and would have provided useful data—but no pictures—on radiation and cis-lunar magnetic fields. The N.A.S.A. now has insufficient funds to repeat the experiment, and there will probably be no further launch of this type until about 1962 with " Ranger 3."

" Lunik 3," the U.S.S.R. probe which successfully photographed a large part of the moon's hidden side in October, 1959, finally re-entered the Earth's atmosphere and burned up on May 20, 1960. Russian activity during 1960 appears to have been confined to the Pacific rockets and the " Sputnik 4," " 5 " and " 6 " dummy spaceships.

Advanced Vehicles.—The N.A.S.A. has under development the " Ranger " and " Mariner " space vehicles, to be launched by " Atlas-Agena " B boosters (Fig. 24). Seven " Ranger " experiments are planned with a vehicle weighing up to 1200 lb, and the first flights due in 1961 will test the craft and its systems. " Ranger 1 " will be an Earth satellite in a highly elliptic orbit of about 600,000 miles apogee, and the second " Ranger " may be an artificial satellite of the sun. " Ranger 3 " (about 1962) will make a rough landing on the Moon, carrying a seismometer in a protected capsule as the main experiment. The seven " Mariner " vehicles are intended to make flights past Mars or Venus. A Venus flight is planned for late 1962 and a Mars flight for 1964. " Mariner " will carry an infra-red tracking system to detect the planet and then lock on and track, keeping the instrument package pointed towards the centre of the planet. Experiments will include spectroscopic measurements in ultra-violet and the visible spectrum, cosmic radiation and cosmic dust measurements, radiation from the planet, and magnetic field measurements. A thermistor bolometer sensor has been chosen for the " Mariner " tracking system, for this gives the high sensitivity required without needing cooling.

Next under development will be " Surveyor," a vehicle launched by " Centaur " and capable of soft-landing up to 300 lb of equipment on the Moon some time in 1963 or 1964. Others—planned for 1965—are " Prospector " and " Voyager " for launching by " Saturn." " Prospector " will be a mobile craft, soft-landed on the lunar surface for exploration purposes. " Voyager " will be designed to go into orbit round Mars or Venus, to eject an instrument capsule for atmospheric entry and possibly landing, and to relay data telemetered from the capsule back to Earth.

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(*To be concluded*)

Transatlantic Communications Satellite Tests

As reported briefly in our April 7 issue, page 560, the Post Office is to co-operate with the U.S. National Aeronautics and Space Administration and the French Centre for Telecommunications Studies in a programme for trans-Atlantic testing of communications satellites. Ground stations are to be built in England and France for the reception and transmission of telephone, telegraph and television signals across the Atlantic using satellites to be launched by N.A.S.A. during 1962 and 1963 in projects " Relay " and " Rebound." Provision will be made for tests both with active and passive satellites at high frequencies and low power.

The satellite in the N.A.S.A. low-altitude active repeater programme " Relay," to be launched 1962, will weigh less than 100 lb. In addition to equipment for the communications experiments, instruments will detect radiation damage and other effects of space conditions on critical components. The " Rebound " project will follow up the first N.A.S.A. passive reflector communication satellite programme " Echo." It involves placing several rigid inflated spheres in orbit by means of a single launch vehicle. The first launch, to orbit three spheres, is programmed during 1963.

Both these projects are for research and development to demonstrate feasibility, basic concepts and technological approaches and to evaluate various systems to be employed in communications satellites. To an extent permitted by orbital and other technical considerations, it will be possible for other countries wishing to do so to provide ground facilities for participating in these co-operative experiments. The siting and equipment of the British ground station, and therefore the cost, have not yet been settled, but it will probably be situated in the south-west.

OBITUARY

SIR ALEXANDER ROGER

We regret to record the death on April 4 of Sir Alexander Roger, K.C.I.E., who was connected for many years with the cable industry and associated telecommunications activities. He was born on January 30, 1878, and trained as an accountant. On first coming to London at the age of eighteen he worked chiefly with various trust companies. During the 1914–18 war he was Director-General, Trench Warfare Supply Department, Ministry of Munitions, from 1915 to 1917 and was knighted for his services. In 1918 Sir Alexander joined the board of British Insulated and Helsby Cables, Ltd., and in 1928 was elected vice-chairman. He became chairman in 1930. When the British Insulated company was amalgamated with Callender's Cable and Construction Company, Ltd., in June, 1945, he became chairman of the combined undertaking, British Insulated Callender's Cables, Ltd. On retiring from the position in 1954, he became the first Honorary President of the company. At the time of his death he was also Honorary President of the Automatic Telephone and Electric Company, Ltd., and up to 1960 had held the chairmanship of Telephone and General Trust, Ltd. In a career linked with B.I.C.C. and with other cable and telephone activities for forty-three years, Sir Alexander had also been chairman of several telephone operating companies in Portugal and the West Indies. Among his numerous activities outside the communications field, Sir Alexander had been vice-president of the Federation of British Industries and of the Anglo-Portuguese Society.

RICHARD KIRCHNER

It is with regret that we have to announce the sudden death on Saturday, April 1, of Mr. Richard Kirchner, M.I.Mech.E., M.I.Prod.E. Mr. Kirchner, who would have been fifty-three next month, was deputy chairman and joint managing director of Arnott and Harrison, Ltd., and a director of Crawford Collets, Ltd., and Omes, Ltd. He was educated at Wilsons Grammar School, London, and Bonn University, and started his apprenticeship with Elephant Motors, Ltd. in 1924. During his apprenticeship he attended the Borough Polytechnic and, on completion of his time in 1928, went to Arnott and Harrison, Ltd. as a draughtsman.

Throughout his career Mr. Kirchner took a keen interest in the gauge and tool industry and was a founder-member and signatory to the original memorandum and articles of the Gauge and Tool Maker's Association. From its inception Mr. Kirchner was a member of council of the association and served as honorary treasurer from 1947 to 1956. He was made a vice-chairman of the association in 1956 and last year was appointed a vice-president.

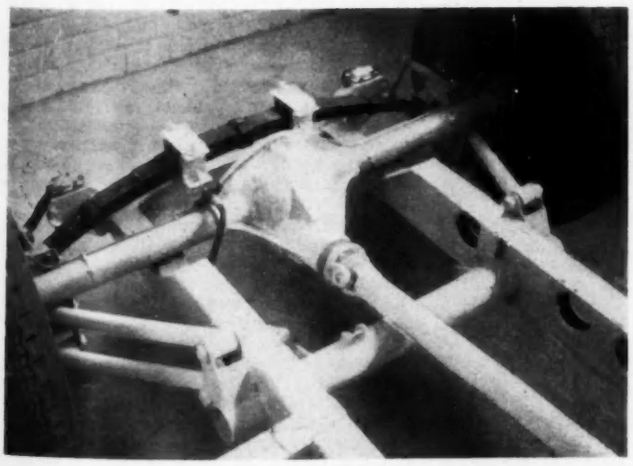
"Turnkey" Mechanical Engineering

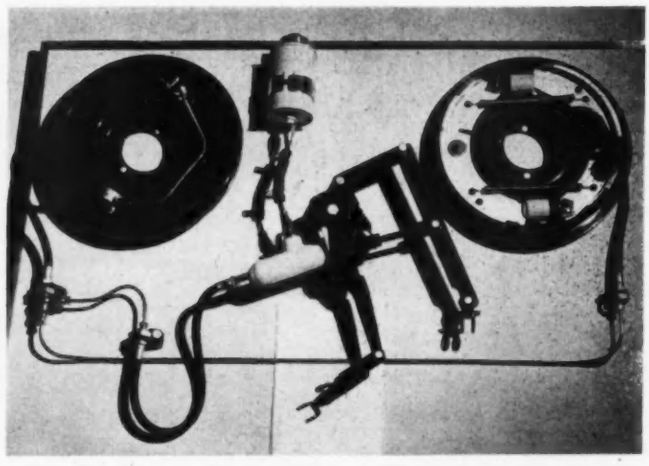
The opening of the new factory of L.M.B. Components, Ltd., at Weyford House, Woodbridge Meadows, Guildford, Surrey, allows the firm to offer a complete mechanical engineering service analogous to that of a civil engineering contractor on a " turnkey " contract. The firm will not only investigate any requirement that is placed before it, conceive and build prototype equipment, and develop the design to reach an optimum solution, as hitherto, but in the new workshops will undertake production of quantities not large enough to call for automatic tooling.

The firm was founded by its managing director, L. M. Ballamy, whose initials are familiar as describing independent front suspensions of swing axle configuration ; such suspensions are, it will be recalled, found predominantly on sports cars where accuracy and responsiveness in handling can justify the need for widely spaced mounting points and long swinging links. While automobile engineering has continued to be the principal field of activity of Mr. Ballamy, he has worked both as a consultant and designer in mechanical and production engineering, but naturally has specialised on problems in which light weight and high performance are desiderata and the user is prepared to pay for a highly refined design. The acquisition of manufacturing facilities in the same building as the design office will mean that prototypes and test rigs will be made available more rapidly, and that production items will be machined, inspected and assembled by staff having immediate access to the engineer responsible for the design.

The workshops are essentially machine shops, equipped for turning, boring, milling, welding and grinding ; the machining work on the firm's own products is done under its own roof, castings and forgings being bought in. There are also a clean assembly room for building up engines and similar delicate plant, and a garage with a hoist for small and medium-sized vehicles. In course of installation for use in engine testing is a Walker air brake or fan dynamometer, which is situated in the open air and driven by a shaft passing through the wall of the building, in order to reduce the noise in the test house. One specialised facility that the workshops offer is that of fitting Cross wire thread inserts, either to repair damaged female threads or to allow steel bolts to be run into light alloy components.

A number of the products stemming from the firm's own initiative have already been described in The Engineer, including, of course, a swing axle i.f.s. (page 630, November 1, 1957), and a complete chassis (page 62, January 8, 1960). The firm was, so far as we are aware, the first to attribute the wide variation in fuel utilisation between different examples of the Ford 100E engine to lack of control over the natural frequency of the resilient engine mountings—the ill-effects of resonance within the working range were observed on an experimental unit with an Amal carburetter, flooding of which was conspicuous at resonance—and hence it markets an engine mounting damper as a fuel economy device. We illustrate here a recent introduction, a kit for converting Ford cars with the large (10in diameter) brakes to hydraulic brake actuation at the front ; such conversion greatly facilitates the installation of independent front suspension, while retaining the conspicuous virtues of the Ford installation that manual reversion is necessary only in the improbable event of a brake pedal breakage and that the handbrake linkage is efficient, is unaffected by load variation, and adds little to the total cost and complexity of the system. Conceptually, it is only necessary to replace the original compression tube (which transmits the output of the balance beam to the rear brakes but allows the rear linkage to move " on " without affecting the pedal and front linkage) by a hydraulic master cylinder and suppress the travel of the front-to-back force balance beam. However, to do this would require either a master cylinder smaller or a shoe motor larger than standard, and so (to ease initiating production and maintenance in service) standard components have been adopted and a linkage incorporated to raise the force upon the master cylinder to four times that on the erstwhile compression tube. The weight of the master cylinder and the levers is carried from the main crossmember on which are mounted the rear brake lever and the hand-





(Left) L.M.B. mechanisms normally exhibit kinematic perfection, but an exception is the rear suspension geometry of the " B " (open propeller shaft) chassis, which is redundant in the pitching plane and functions in the lateral plane only by virtue of the controlled stiffness of the pivots. The reason for this is that the Salisbury axle, having been designed for Hotchkiss drive installations, will not support torsional loading. (Right) Components of kit to convert Girling mechanical brake linkage to hydraulic operation of the front brakes while retaining pedal operation after failure of any working part ; the cylinder and linkage are seen as from below

brake bell-crank. It is of some significance that, except for parts such as seals and rolling bearings, which will need renewal in service, the firm makes little effort to design around existing parts, since it has been found that, even when the quantities required are available off the shelf, parts machined in-house are little or no more expensive, the economy of mass production having been offset by the expenses of storage, packaging, carriage and inspection.

Elstree Television Studios

THE Elstree Studio Centre of Associated Television, Ltd., was formally opened on April 7 by Dr. the Rt. Hon. Charles Hill, P.C., M.P., Chancellor of the Duchy of Lancaster. Two of the four studios on this site are already in operation, and when the other two are opened in a few months' time the total studio floor area will be nearly 32,000 square feet. Adjoining the studios are a seven-storey administration block, two three-storey buildings for studio and technical facilities, and a transport and workshop building providing all facilities required for the A.T.V. fleet of vehicles, including those used for radio links in outside broadcasts in this country and on the Continent.

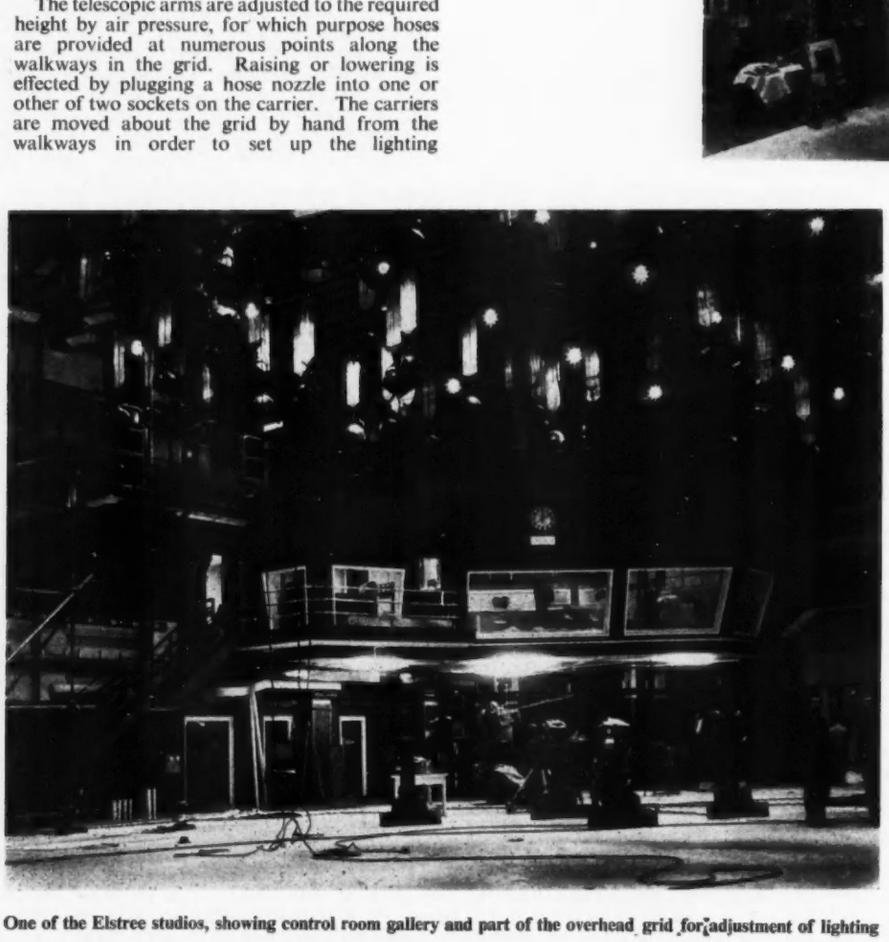
Each studio is equipped with five Pye 4½in image orthicon cameras on electrically propelled trollies, and with mobile monitor screens for viewing by staff on the studio floor. Cameras are linked by a 32-way cable with the camera control room in which are situated the consoles for monitoring the camera performance and adjusting the operating potentials of the orthicon tubes. Adjacent to this room are the producer's, sound and lighting control rooms. Lighting facilities in each studio comprise some 300 lamps with a loading of 350kW. Sufficient power capacity has been provided to meet the requirements of colour T.V. The lamps, mainly tungsten but including some carbon arcs, are suspended by telescopic arms from wheeled carriers running on a grid of tracks in the studio ceiling, so that any lighting unit can be traversed in two directions to any desired position. Units can also be moved alongside a gallery for relamping, or run out of the studio into the lamp store.

The telescopic arms are adjusted to the required height by air pressure, for which purpose hoses are provided at numerous points along the walkways in the grid. Raising or lowering is effected by plugging a hose nozzle into one or other of two sockets on the carrier. The carriers are moved about the grid by hand from the walkways in order to set up the lighting pattern required by the lighting controller.

The remote switching and dimming facilities provided from the twenty-four-circuit lighting control panel include a storage feature enabling up to twenty lighting combinations to be pre-selected and brought into effect later by operating a single push button. Dimming is effected by transformers with tapped secondaries. All tap-changing switches in a dimmer bank are operated by a single motor and are connected to the drive in the combinations required by means of electromagnetic clutches. The lighting control system was supplied by Strand Electric, Ltd.

The sound control consoles and amplifiers are being supplied by Pye, Ltd. When the installation is complete the amplifiers will be fully transistorised, including the power output stages, and all units will be accommodated in the control consoles. More than half the apparatus installed at Elstree is transistorised, including that for pulse generating and distribution, and for picture signal distribution and mixing. The use of transistors reduces the bulk of equipment by 5 : 1 and the heat generated by 10 : 1.

Lighting units suspended by telescopic arms from overhead trollies



One of the Elstree studios, showing control room gallery and part of the overhead grid for adjustment of lighting

All equipment is capable of operating on 405-line 50-frame, 625-line 50-frame, and 525-line 60-frame standards. Studio pictures may be recorded on video tape at any of these standards.

The vision mixer panel and associated apparatus are entirely of A.T.V. construction. The whole mixing operation is effected by the use of germanium diodes and provides inter-frame cutting, i.e. picture cuts in the frame blanking period so that a perfectly clean cut without deformation of one or more picture frames is assured. In addition to cutting and mixing pictures, the vision mixing panel provides the utmost flexibility in superimposition of pictures, montage and trick effects, wipes, iris effects, and so on. Until the very recent introduction of similar equipment in the U.S.A., this is said to have been the only transistorised mixer operating in the world.

Programmes from Elstree are normally transmitted to the A.T.V. control centre at Foley Street in London over coaxial cable, but an E.M.I. microwave transmitter is installed at the studios and operates via a repeater station in Hertfordshire to Highgate, whence there is a cable link to the Foley Street. Mobile microwave equipment at Elstree comprises five outside broadcast vehicles, and an hydraulic tower vehicle which can be erected to a height of 60ft and often enables the number of "hops" required in a transmission path to be reduced materially. Microwave transmission is normally used only for the vision signal, the sound being routed separately by Post Office cable and v.h.f. transmission.

SHORTER REPORTS

Co-operation of Metallurgical Institutions

THE councils of the Iron and Steel Institute, the Institute of Metals and the Institute of Metallurgists have recently discussed the problems of closer co-operation between the three societies. They concluded that amalgamation of the three organisations would not be practicable within the foreseable future, but that a permanent joint consultative committee should be set up to advise the three councils on matters of common interest. Accordingly, this committee has been established ; it has nine members, three from each of the bodies concerned. The committee has held its first meeting, and will meet regularly in the future to consider and to advise the three councils on activities and questions of common interest.

The three councils are convinced that it would be to the advantage of every qualified metallurgist to be a member both of the professional institution and of the appropriate scientific and technical institute. With this in view the Council of the Institution of Metallurgists has altered the standard subscriptions payable by members, enrolled graduates and enrolled students resident in the United Kingdom, and by agreement between the three councils all those in the Institution of Metallurgists who pay the revised subscriptions will automatically have the right to apply for membership of one of the two Institutes without liability for payment of a further membership subscription.

It is recognised by the Council of the Institution of Metallurgists that members who are not already members of one of the Institutes as well will be called upon to pay what may seem at first sight to be a large increase in subscription, but it draws attention to the fact that all younger metallurgists—a very large proportion of the Institution's membership—will be receiving much more in service and publications than could be financed by the amount of their subscription. Those who already have dual membership will find that the new standard subscription represents a considerable improvement on the present position, and strengthening of all three bodies will enable better service to be given to all members.

Power Station Sites in the West Riding

THE Central Electricity Generating Board states that two of the sites investigated in the West Riding of Yorkshire have been found suitable for large coal-fired power stations. One is an extension of the Board's existing site at Ferrybridge (between Knottingley and Castleford) where two stations with an aggregate plant capacity of 470MW are now in operation. The other is at Eggborough, about 4 miles east of Knottingley. Both sites are on the eastern fringe of the Yorkshire coalfield, which is second only to the adjoining East Midlands coalfield as a producer of coal for electricity generation. The Yorkshire coalfield possesses large reserves and the National Coal Board expects in the future to supply substantially increased quantities of the small coals that power stations can burn efficiently. The Ferrybridge site already has a rail connection and, being on the navigable part of the River Aire, it can also receive coal in barges. The Eggborough site can be rail-connected by a short spur off the Wakefield/Knottingley/Goole railway. Each site is considered suitable for a station of about 2000MW capacity, burning some 5,000,000 tons of coal a year. Both are on the River Aire, which is the only adequate source of cooling tower make-up water in this part of the coalfield.

Early construction of both stations is necessary to meet the rapidly increasing demand for electricity and the Board is applying to the Minister of Power and the West Riding County Council for the necessary statutory consents. If authorised, the stations will incorporate the large highly efficient boiler and turbine units that characterise of the Board's current development programmes.

A third site, on the River Aire at Gowdall, to the east of Eggborough, is believed to be potentially suitable for a station to meet later growth of demand, subject to further study of cooling water problems. Further investigations are also required into the problems of siting a station on the River Don additional to the 1100MW Thorpe Marsh station now under construction about 4 miles N.N.E. of Doncaster.

Narrow-Gauge Railway Preservation

RAILWAY conversion in a new manner is one of the objects of the recently formed Hampshire Narrow Gauge Railway Conversion Society, which is negotiating with British Railways for use of part of the roadbed of the Meon Valley line, Alton to Fareham, on which to lay a short 2ft gauge track. A beginning would be made with a static exhibition of remaining narrow gauge equipment, following this with track laying and an eventual goal of about 4 route-miles of line. A Bagnall 0-4-0 saddle tank locomotive has been acquired already from the quarry where it had been employed, shortly before it would otherwise have passed into the hands of scrap dealers. The society feels that there is a future for a privately-operated narrow-gauge line in the South of England on which trains could be run to a timetable as on the similar systems in Wales, and which would become in effect an " animated museum " of narrow-gauge practice. The honorary secretary is Mr. W. B. Lyman, 1, Bishops Close, Totton, Southampton, and the annual subscription is £1, or 10s. for members under 18 years old.

Start of Construction at Sizewell Nuclear Power Station

WORK began on April 4 on the construction of the atomic power station at Sizewell, Suffolk, which is being built for the Central Electricity Generating Board by the English Electric, Babcock and Wilcox, Taylor Woodrow atomic power group. On completion in 1966 it will have a capacity of 580MW. In all, excavation for its construction will amount to over 500,000 cubic yards, but before detailed excavation of the foundations can begin, it is necessary to move and level approximately 300,000 cubic yards of sand. Bulk excavation methods are being used to move this quantity within five weeks of the starting date. While this is in hand, progress is being made on a system of access roads round the site and the erection of the many temporary buildings required. It is expected that by the beginning of July detailed excavation of the reactor foundations will be well advanced, and the majority of the temporary works required initially on site will be in operation.

An important feature of the civil engineering work will be the construction of the cooling water intake, 1800ft from the shore, through which sea-water will be drawn at the rate of over 27,000,000 gallons an hour, and after use, discharged at a point 500ft off-shore. Four tunnels of 10ft diameter have to be driven, under compressed air, to positions below the intake or outfall. Shafts will then be raised through the sea bed to form intake and outfall, which will be finished from working platforms established above high water level.

Thermal Ampere Demand Meter

THE thermal ampere demand meter illustrated has been introduced by Ferranti, Ltd., Hollinwood, Lancs., primarily for overseas markets. The demand indicator is incorporated in a single-phase kilowatt-hour meter. Features of the unit include the use of light alloy gears and viscous damping on the demand indicator pointer. Scale length is 5in.

The indicator comprises two bi-metallic strips, one of which is enclosed in a heated chamber, while the other remains at ambient temperature. The heating element consists of a tubular

Combined ampere demand and kilowatt-hour meter

former moulded in two halves from a heat-resistant plastic. In each half, strip, of a copper-manganese-aluminium alloy are embedded, through which the main current is passed. Series or parallel connection can be made depending upon the current rating.

One end of the heated strip, which is about 4in long, is firmly anchored to an insulated block and the free end is connected by an insulated link to the strip at ambient temperature. The other end of this strip is pivoted and carries a toothed sector which engages with a gearwheel mounted on a spindle which in turn drives the pointer. Retention of the maximum demand indicating pointer is provided by viscous friction between two steel plates which sandwich a silicone grease. This device provides stability under conditions of vibration or shock and presents a very small mechanical burden to the meter.

When the enclosed strip is heated, it is deflected to operate the driving pointer. This in turn pushes the indicator pointer around the scale, where it remains at the highest deflection of the driving pointer. The second strip acts as an ambient temperature compensator.

The thermal indicator has an approximate square law, the divisions representing units of current becoming larger as the current increases. Time lag is sixteen minutes for 90 per cent indication.

Overall dimensions of the combined kilowatt-hour and thermal ampere demand meter are : height 9·14in ; width 5·75in ; depth 5·257in. Weight is 6 lb 1 oz. Nominal current ratings are 5A to 60A with 50 per cent overload capacity.

[Reply Card No. E6115]

SHORTER REPORTS *(Continued)*

Major Drainage and Salinity Survey in Pakistan

A CONTRACT valued at £1,000,000 has been awarded by the Water and Power Development Authority of West Pakistan to Hunting Technical Services, Ltd. The contract involves drainage and salinity control investigations of some 10,000,000 acres of irrigated land. Hunting has engaged Sir Murdoch MacDonald and Partners as engineering consultants. The first contract of this kind was awarded to Hunting late in 1959, and is now at the stage where a report has been submitted to the Authority ; the present contract is very much larger in size, though similar in character, to the first.

The irrigated land involved in these surveys is in the lower Indus Valley, where the river is controlled by three barrages. The barrage furthest upstream—Gudu barrage—is under construction. Next below it is the famous Lloyd barrage at Sukkur, which commands about 5,000,000 acres and was completed in 1932. And below that again is the Ghulam Mohammed barrage at Kotri, which was completed in 1954, and commands nearly 3,000,000 acres.

The problem which now faces these irrigated areas and has become increasingly urgent in the last few years, is that of the dual phenomena of waterlogging and salinity. Before the barrages were built, seasonal irrigation was practised, and in the dry season the land dried out and the water table—which was at some depth—sank to something like its natural level. With perennial irrigation, however, there is a constant tendency for the water table to rise, due to leakage from canals, to the absorption of water in the fields and plantations, and so on, all irrigation water being accounted for either by evaporation or by seepage of this kind, there being no major outflow at the downstream end of the canal system. Ultimately then, the land may become a swamp, after a period of years under irrigation. Should the natural ground water be saline, as the water table rises, salinity will first obstruct the fertility of the soil, and will eventually leave deposits of salt on the surface when the water table has reached it and evaporation becomes heavy. Thus waterlogging and salinity tend to occur together.

These phenomena were well-known to the builders of the Lloyd barrage, as is evinced by the number of gauging points installed to observe the water table in the irrigated lands ; in fact a scheme of amelioration was put forward in 1937, but was never implemented. Clearly, however, the problem cannot be tackled before it occurs, and there is perhaps a twenty or thirty year period before it becomes serious. In this case the water table in the lands commanded by the Lloyd barrage was originally something like 14ft below the surface. It has been rising at a rate of about one-third of a foot per year. A contemporary map shows large and fertile areas where the water table is now within 150cm of the surface, which therefore have perhaps a decade of useful life if nothing were done. The problem is somewhat acute, however, over all the 25,000,000 or so acres of irrigated land in West Pakistan, and in other regions extensive tube well schemes are in hand to combat such conditions.

Techniques of evaluating this problem in a quantitative manner now exist in a much more developed form than twenty years ago, and even in the past year or two, techniques with tube wells have advanced quite substantially in Pakistan, we understand. The surveys which fall within the present contract aim at measuring the depth of the water table and the salinity of the ground water, the nature of the aquifers, and the permeability (expressed in the results as " drainability ") of the soils. A great deal of drilling to depths of say 600ft, is involved. From information of this kind it is possible to deduce whether it will be more practicable to drain waterlogged land by a system of drainage ditches, or by tube wells. Should the ground water be very saline, for instance, it might have to be led back to the main river in a special conduit, thus rendering such a scheme expensive. In addition, recommendations on irrigation practice, and in some cases on the most suitable crops (e.g. ones requiring small quantities of water, or ones tolerant of some salinity) can be made, and factors such as leakage from irrigation canals can be assessed. To sum up, the feasibility and economics of open drains and tube well systems have to be compared, and agricultural methods of water table control considered. Having achieved " drainage," salt can then be flushed out.

The earlier of the two contracts referred to above has resulted in recommendations for actual construction of the first of the schemes of this kind. It concerns 300,000 acres in the Khairpur region, fed by one of the main canals from Lloyd barrage, part of which will be drained by an open drainage system, it is considered.

In addition to these various studies a pilot project of some 5000 acres will be established at an early stage to compare construction and maintenance costs of land drained by open and by tile drains, and to provide a centre for carrying out various reclamation trials.

Hunting Technical Services, Ltd., describes its services as those of " consultants and specialists in resources development." As the main contractor the firm will be responsible for general planning and for the varied investigations such as soil surveys, soil permeability studies, groundwater studies and agricultural studies. Sir Murdoch MacDonald and Partners, will carry out the engineering investigations, design drainage layouts and structures, and will prepare contract documents and specifications. For the programme of drilling and of tube well construction, the British firm of Drilling and Prospecting International, Ltd. (associates of Turriff Construction Corporation) has been re-engaged to extend the drilling programme of the earlier investigations. Studies and design work will continue until 1963, but the installation of drainage systems will start progressing as investigations of separate smaller areas are completed.

[Reply Card No. E6121]

500MW Tandem Compound Turbo-Generators for the C.E.G.B.

WE have received from C. A. Parsons and Co., Ltd., Newcastle upon Tyne 6, some design information about the four 500MW turbo-generators which this company is to supply to the Central Electricity Generating Board, as announced in our issue of March 7, 1961, page 431.

A photograph of a model of one of the sets as seen from the steam end, is reproduced here to give an impression of the layout. Each of the four sets will consist of a single line of tandem compound turbines, operating with steam at a pressure of 2300 lb per square inch, 1050 deg. Fah. temperature, with reheating to 1050 deg. Fah. and driving a hydrogen/liquid cooled 500MW generator at 3000 r.p.m. From the exhaust of the h.p. turbine the steam will be reheated and passed to a double-flow i.p. turbine. On leaving this turbine the steam will complete final expansion through the double-flow l.p. turbines. The h.p. cylinder will be of double casing construction, whilst the i.p. cylinder will have a partial double casing. Each of the l.p. cylinders will comprise an outer fabricated shell and cast inner blade carrier. Cascades will be fitted in the exhausts of each l.p. cylinder. A hollow construction of both the h.p. and i.p. turbine shafts will be used to obtain a thermal inertia comparable with that of the casings, to assist in rapid starting and loading.

Two steam chests, each containing two emergency stop valves and two governor valves, will be arranged one on either side of the h.p. turbine. Intercept valves will be fitted in the steam lines between the reheater and i.p. turbine, with reheat emergency stop valves as an additional safeguard. The intercept and emergency stop valves will be housed in external steam chests, one on either side of the h.p. turbine. Governors housed in the h.p. turbine outer end pedestal will control the valves by oil relays arranged at the side of each steam chest. There will be seven stages of feed heating by steam bled from the machine, the feedwater being heated to a final temperature of 485 deg. Fah. at full load.

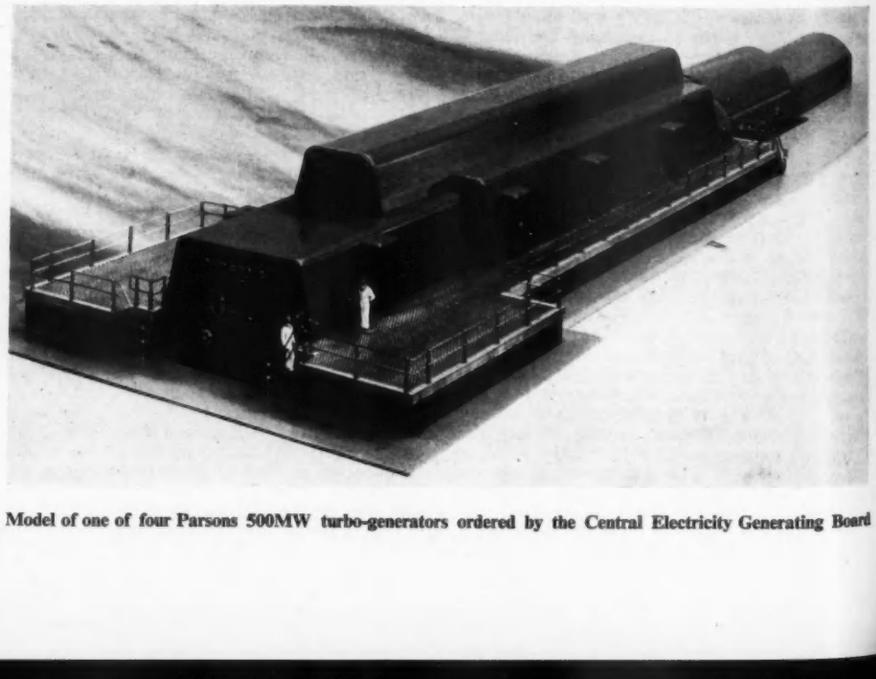
Each generator will have a rating of 588MVA, at 0·85 p.f., generating at 22kV. The rotors will be direct cooled, operating in hydrogen with a pressure range of 45 lb to 60 lb per square inch.

Direct-cooled windings will be used on the stators, the cooling medium being demineralised water. In their general construction both rotor and stator follow normal practice. The stators will be of two part construction, consisting of an inner frame to carry the stator core and windings and an outer casing to house the hydrogen coolers.

The rotors will be single piece forgings, with cooling of the windings by means of sub-slots machined below the main winding slots and fed with hydrogen at each end. At intervals along the coil there will be radial ventilating slots which will exhaust through the retaining wedges into the air-gap. Fans mounted at each end of the rotor body will circulate the hydrogen through the rotor and stator ventilating passages and then through the coolers before recirculation.

Excitation for each generator will be provided by a direct-driven a.c. exciter feeding the main generator rotor through a silicon rectifier.

[Reply Card No. E6122]



Model of one of four Parsons 500MW turbo-generators ordered by the Central Electricity Generating Board

Variable-Speed, Single-Phase A.C. Motors

A REVERSIBLE, variable-speed, single-phase a.c. motor, with good speed regulation characteristics has been developed by Mawdsley's, Ltd., Dursley, Gloucester, and was demonstrated recently at the Electrical Engineers (A.S.E.E.) Exhibition at Earls Court. It is known as the Mawdsley-Mensforth variable-speed motor and it is designed to overcome the difficulties usually met in attempts to provide variable speed with shunt excitation in an a.c. motor.

As can be seen from the circuit diagram (Fig. 1)

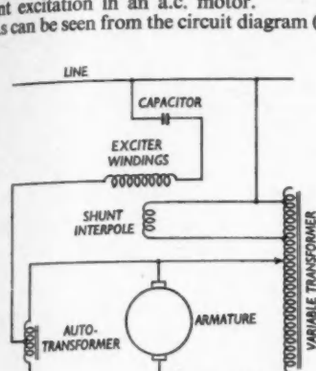


Fig. 1—Basic circuit diagram of Mawdsley-Mensforth variable-speed, single-phase a.c. motor

the main exciting winding is tuned with a capacitor with the object of bringing the excitation current into phase with the mains supply voltage. The field system is a distributed winding in the stator and consists of a main excitation winding, neutralising windings and shunt and series interpole windings. Speed variation is effected by a variable transformer ("Variac") which controls the applied armature voltage. Constant torque is obtainable over a speed range of 0-3000 r.p.m. in both directions of rotation.

In the upper part of the speed range when the voltage applied to the armature by the variable transformer is high, the shunt interpoles are fully effective. The induced "transformer" volts are neutralised and the parasitic currents caused by the brushes short-circuiting the commutator bars are small. The excitation winding, which is tuned by the capacitor therefore has a high value of Q: that is to say the voltage applied is small compared with that appearing across the field winding. However, at low speeds the value of Q falls and the applied voltage must, therefore, be increased to keep the excitation current correct in magnitude and phase. This condition is achieved by a small auto-transformer which is fed through the slider of the main variable transformer, as shown in Fig. 1.

Special attention has been given to the design of the armature. The dimensions of the commutator and the number of bars in it are made sufficiently large to limit the "transformer" voltage short circuited by the brushes. To limit the "transformer" parasitic currents resistance connectors are embedded in the armature slots and connected between each commutator bar and the appropriate armature coil. An unusually robust design of brushgear has been developed by Mawdsley's in conjunction with the Morgan Crucible Company, Ltd. The brush position is set at the factory and no further adjustment is required, irrespective of the direction of armature rotation. Copper-silver alloy is used for the commutator bars and class-E insulation for the windings.

Light alloy castings are used for the enclosure and the normal enclosure is drip-proof. The first machine built has a rating of 2 h.p. at 3000 r.p.m., and *pro rata* at lower speeds. Ratings of 1 h.p., 3 h.p. and 5 h.p. at 3000 r.p.m. are also available. Motors of other ratings are under development. The motor and associated control gear are suitable for a single-phase voltage of 230V to 240V, 50 c/s, connected between phase and neutral of a three-phase supply. By adjustment of a transformer tapping other mains voltages up to 250V can be accepted.

With constant mains voltage the speed is controlled by V_{as}, the voltage applied by the variable transformer. Typical curves are shown in Fig. 2, from which the regulation obtainable

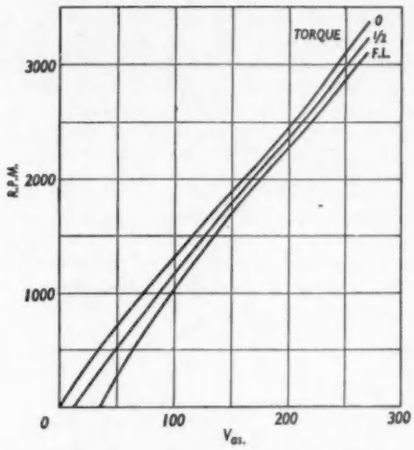


Fig. 2—Speed regulation curves of Mawdsley-Mensforth variable speed motor

over a wide speed range can be deduced. These curves suggest that the motor is well suited for such applications as small planing-machine table drives which require a stable low speed for cutting and a high speed for the idle return stroke, taking advantage of the inherent regenerative braking of the system.

The effects of fluctuations in mains voltage on speed are comparatively small as shown by the following figures :

Approximate speed, r.p.m.	Mains voltage, V	Speed change, no load, per cent	Speed change, Full load torque, per cent
3000	250	+5½	+3½
—	210	−3	−4
2000	250	+3	+2
—	210	−2	−2½
1000	250	+1	+2
—	210	−1	−5

The power factor of the load on the supply is high, being nearly unity at high speeds and not less than about 0·86 at low speeds. At standstill the motor exerts full-load torque with only 100 per cent of full-load armature current, while taking less than 30 per cent full-load amount from the mains.

Typical curves of the overall efficiency of the motor together with its control gear are reproduced in Fig. 3.

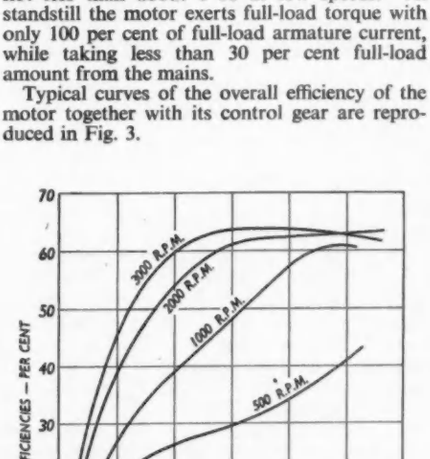


Fig. 3—Overall efficiency of Mawdsley-Mensforth variable speed motor

The basic control gear which will be suitable for most applications consists of a variable transformer ("Variac") for speed control, a main contactor, a master controller for "On/Off" switching and for reversal, and a thermal overload trip. These items are normally enclosed in a small rectangular sheet steel case. For certain applications, such as hoists, which demand "plugging" to arrest a descending load without operating the reversing lever, the only adjustment needed is that of changing a tapping on the variable transformer.

We learn that devices to stabilise the speeds over the working range, by compensating for the inherent regulation of the motor, are being developed, as are equipments for presetting the speed and for providing automatic acceleration by push-button control.

[Reply Card No. E6131]

Progress with the London–South Wales Motorway Project

Two further stages in the construction of the first 24 miles of the London–South Wales motorway have been announced by the Ministry of Transport. One is the letting of contracts for the 5½ mile Slough by-pass ; the other is that tenders are being invited for the initial works in the construction of the 12 mile section between the Chiswick flyover and Langley, Bucks.

Tenders for the Slough by-pass submitted jointly by Higgs and Hill, Ltd., and Richard Costain (Civil Engineering), Ltd., amounting to £4,098,874, have been accepted. The work is to be completed in two years. The by-pass will have two 24ft carriageways, each with a 10ft wide hard shoulder and separated by a 13ft central reservation. Its construction will include eleven bridges, two flyovers, three roundabouts and nine major culverts. The works have been designed for the Ministry of Transport by the agent authority, Buckinghamshire County Council whose county surveyor is Mr. E. H. Frankland, M.I.C.E.

Tenders are now being invited for altering the Chiswick end of the Great West Road prior to the construction of the 2 mile long viaduct which will carry the London–South Wales motorway between the Chiswick flyover and Boston Manor Road. The two 30ft carriageways of the Great West Road are to be re-positioned to allow for an 18ft central reservation, on which the supports for the viaduct will be erected under the next contract. Pedestrian subways will be provided at intervals along this stretch.

This work should be completed by the summer of 1962 the Ministry states, and it is hoped this summer to invite tenders for construction of the viaduct itself for completion early in 1964. Contracts for the remainder of the road will be timed for completion at the same date. The motorway will have dual 24ft carriageways on the viaduct section and dual 36ft carriageways from this point to Langley. The spur from the motorway to London Airport will also have dual 36ft carriageways. The roadworks and the viaduct have been designed for the Ministry of Transport by the consulting engineers, Sir Alexander Gibb and Partners.

Both of these road schemes are now of long standing. The route of the Slough by-pass was published in this journal at the time that the first contracts for the Maidenhead by-pass were let (that is, in our issue of April 24, 1959, page 665). The Maidenhead by-pass is now nearing completion, though the original estimates were that it would be completed by the end of last year. It extends over about 6 miles, and is costing about £2,500,000. The Slough by-pass is a continuation of this road to the east, and stretches as far as the Chiswick–Langley motorway scheme.

The elevated road was first announced by the Ministry of Transport about three years ago, and was described in THE ENGINEER of March 28, 1958, page 429. At that time the scheme was hailed as a great advance in official thought on the urban road problem, but as can be seen it has taken three years to reach the stage of letting preliminary contracts, and completion is scheduled for 1964.

INDUSTRIAL NEWS

Economic Survey

The White Paper, " Economic Survey, 1961," was published last week. Reviewing last years' economic trends, the " Survey " says that the rapid expansion of total demand and output which took place in 1959 continued in the early months of 1960. At the beginning of the year pressure on reserves was increasing, shortage of labour and materials were re-appearing, delivery dates tended to lengthen, and imports were rising rapidly. Largely as a result of a series of restraining measures taken by the Government, the rise in home demand slowed down considerably after the first quarter. In the last three quarters of 1960, the " Survey " states, there was no net rise in industrial production. Civil employment went on rising and there was a decline in the number of wholly unemployed. During 1960 the rise in earnings per head accelerated and in the second half of the year they were 6½ per cent higher than in the second half of 1959. National productivity did not rise as much. The " Survey " stresses that if increases in pay continue to outstrip the rise in national productivity, the pressure on costs and prices will be intensified and ability to export will be impaired.

For a country in the international position of the United Kingdom, the " Survey " states, it is axiomatic that the growth of the economy must be interlocked with the growth of exports—otherwise the balance of payments situation is bound to frustrate growth and force a reversal of direction. Endeavours by Government and industry to foster the growth of the economy will succeed only if they are also designed to improve the country's competitive power. Growth and competitiveness can never be separated. Commenting on the prospect for 1961, the " Survey " suggests that the economies of Western European countries, including the United Kingdom, and of Japan will probably expand in 1961. It is also reasonable to expect some recovery in North America, and hence expansion in world industrial production. United Kingdom exports may be expected to benefit from any expansion of world trade, the " Survey " adds, but only if they are competitive in price and delivery, and if salesmanship is sufficiently vigorous.

The White Paper says that personal and public consumption are expected to rise somewhat in 1961. There is likely to be a further rapid increase in private investment, it adds, and some in public investment. The rate of stockbuilding, it suggests, will probably fall. The increase foreseen in consumption and investment should be sufficiently large, the " Survey " goes on, to cause a significant increase in total domestic output in 1961, but the size of this increase will depend also on the level of exports and the extent to which total demand is met by imports during the year.

British Export Missions

According to members of the Export Council for Europe on their return from the " pathfinder " missions recently undertaken to Austria, Denmark, France, Italy, Norway, Portugal, Spain, Sweden and Switzerland, a substantial expansion of British exports to Europe can be achieved if existing opportunities are seized promptly and full regard paid to the individual requirements of each country. The detailed reports submitted by each team are being studied by the Council and early next month a consolidated report will be published bringing out the findings of each mission and the recommendations of the Council for action.

The Export Council for Europe was formed in November, 1960, for the purpose of expanding the exports of British goods and services to the nineteen countries which are members of O.E.E.C. The reports of the returning teams have confirmed the value of these missions, the Council says, and further missions will visit Ireland, Holland, Western Germany, Belgium and Luxembourg, Turkey, Finland, Greece and Yugoslavia within the next few months. A mission to Iceland will take place later.

Employment

The Ministry of Labour has announced that during February the number of people in civil employment in Great Britain is estimated to have increased by 13,000 to 23,695,000. The corresponding figure for February, 1960, was some 335,000 lower. The increase in the number of men in employment accounted for most of the change. The largest increase, the Ministry says, was of 22,000 in the construction industries, whilst the main reduction was of 13,000 in the distributive trades. The number of people employed in manufacturing industries as a whole dropped by 8000 during February.

In the week ended February 25, the Ministry reports, the number of operatives working overtime in manufacturing industries was 1,743,000, which was 40,000 less than at the end of November, but over 35,000 more than at the end of February, 1960. In the same week the number of operatives working short-time in manufacturing industries was nearly 108,000, which was 46,000 less than at the end of January and 18,000 less than at the end of November, but 71,000 more than at the end of February, 1960.

The average number of hours of overtime worked by each operative on overtime was eight, the Ministry says, and the average number of hours lost by each operative on short time was ten.

Unemployment

The final unemployment figures for Great Britain at March 13 show that 350,838 people were registered as unemployed, of whom 322,296 were wholly unemployed and 28,542 were temporarily stopped. The number of people unemployed for more than eight weeks was 174,299, the Ministry of Labour states, which was 54 per cent of the wholly unemployed. The total of 350,838 included 47,826 married women and 1758 school leavers.

During the period February 13 to March 13 unemployment fell in all industries and services except shipbuilding and marine engineering where there was a rise of 1000. The largest reductions, the Ministry says, were of 12,700 in the motor vehicle manufacturing industry, including 12,100 employees who had been temporarily stopped, 6300 in the construction industries and 2500 in the engineering and electrical goods group.

The number of unfilled vacancies increased in most industries and services during the period February 8 to March 8. In the manufacturing industries it rose by 7900, including 2200 in the engineering and electrical goods group and 1200 in the motor vehicle industry. Outside of the manufacturing industries, the Ministry adds, the largest increases included 2500 in the construction industry and 1100 in agriculture.

Agricultural Machinery Exports

Figures issued by the Agricultural Engineers Association show that the value of United Kingdom exports of agricultural tractors and machinery has risen from £73,000,000 in 1956 to £128 million in 1960. Since 1956 the Republic of Ireland has replaced Australia at the top of the list of the United Kingdom's most important markets for agricultural machinery, excluding tractors. Markets which have shown steady advances, the Association says, include Italy and the Netherlands.

Safety Regulations for Unsealed Radioactive Substances

A preliminary draft of regulations* governing the use of unsealed radioactive substances was published last week by the Ministry of Labour. This document sets out proposed requirements for the protection of workers in factories (and other places to which the Factories Act, 1937, applies) against radiations and other hazards arising from the use of unsealed radioactive substances. The draft is a complementary code to the statutory draft of regulations (published on March 30, 1961) dealing similarly with " sealed sources " of radioactive substances and machines that produce ionising radiations. The proposed regulations for unsealed radioactive substances will apply to the whole range of radionuclides used in industry (listed in a schedule to the draft) including those used in nuclear reactors and they will, in due course, replace the " Lumenising Regulations " of 1947.

The first part of the regulations deals with interpretation and definitions. The second sets out general precautions; it provides for the instruction of workers about the hazards involved and for the precautions to be taken. The third part covers the testing of personal exposure to ionising radiations and lays down requirements for medical supervision and examinations. The fourth part specifies conditions and methods of working, including regulations relating to permits to work in certain classes of workplaces and stores. A schedule to the regulations stipulates the method of calculating the amount of radionuclides in the context of these regulations. Other schedules specify the maximum permissible levels of contamination and the maximum permissible radiation doses, based on the recommendations of the International Committee on Radiological Protection and supported by the Medical Research Council.

Any observations on these draft regulations should be made in writing to the Ministry of Labour, 8, St. James's Square, London, S.W.1, by July 31.

* " Unsealed Radioactive Substances Regulations " (Preliminary Draft), H.M. Stationery Office. Price 1s. 3d.

PERSONAL AND BUSINESS

Appointments

MR. G. H. THACKRAH, sales manager of Markland Scowcroft, Ltd., has been elected a director.

MR. E. A. ELMORE has been appointed to the board of directors of Gate Machinery Company, Ltd.

MR. R. T. PEMBERTON has been appointed to the board of directors of Stone-Platt Industries, Ltd.

MR. G. E. LUNT has been appointed a director of John Hill and Sons (Iron Founders), Ltd., a member-company of Staveley Industries, Ltd.

MR. LESLIE GIBSON has been appointed assistant chief engineer of the diesel engine division at The English Electric Company's Preston Works.

COLONEL R. W. W. TAYLOR, managing director of Lang Pneumatic, Ltd., has been appointed President of the British Compressed Air Society for the ensuing year.

THE ELECTRICAL RESEARCH ASSOCIATION announces that Mr. James R. Beard, senior partner in Merz and McLellan, consulting engineers, is to be its next President.

THE COMMONWEALTH TELECOMMUNICATIONS BOARD states that Mr. W. W. Shaw-Zambra has retired from the post of secretary general, and has been succeeded by Mr. W. Stubbs.

MR. V. M. G. BENNETT has been appointed to the board of Teddington Aircraft Controls, Ltd. He is divisional director in charge of the sales of the aircraft and the bellows divisions.

MR. W. A. C. MASKELL, M.I.E.E., general manager of The General Electric Company, Ltd.'s telecommunications group at Coventry, has been appointed managing director of the group.

MR. S. H. HOUGH has been elected vice-chairman of the Pitch Fibre Pipe Association of Great Britain in succession to Mr. D. Kirkness, who has relinquished office after serving in that capacity for four years.

THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION has announced the appointment of Mr. Robert Walter Keith Blagbrough as secretary of the BEAMA electric traction section.

THOS. W. WARD, Ltd., has announced the appointment of Mr. Stanley Jessop as manager of its works at 18-24, Fore Street, Scotstoun, Glasgow. He will be in charge of the company's engineering interests in Scotland.

MR. N. A. C. JAMES, southern England area manager, Cape Insulation and Asbestos Products, Ltd., has been appointed controller, Government contracts division. Mr. N. H. Wimhurst becomes the new southern England area manager.

MR. W. WASHBOURNE, who was appointed general manager of the excavator division of Newton Chambers and Co., Ltd., at the beginning of this year has now been appointed a director of two Newton Chambers subsidiary companies—NCK-Rapier, Ltd., and Rhodes and Halmshaw, Ltd.

E. B. BISHOP has been appointed secretary of Metal Cleaning, Ltd., a member of the Castrol Group of Companies. He succeeds G. J. B. Williams who is now to concentrate on this company's re-organisation and sales development. Both Mr. Bishop and Mr. Williams are directors of Metal Cleaning, Ltd.

MR. C. D. MORGAN, secretary of the British Road Federation since 1953, has been appointed to be secretary of the Institution of Structural Engineers in succession to Major R. F. Maitland who retires on October 1. Mr. Robert Phillipson is to succeed Mr. Morgan as secretary of the British Road Federation.

DARCHEM ENGINEERING, Ltd., a member of the Darlington Chemicals Group, announces that Mr. A. B. Miles has been appointed chief engineer and has been succeeded as chief draughtsman by Mr. F. Meadows. Mr. D. A. Rowlett has been appointed manager of the Rostenit (stainless steel lining process) Division.

MR. D. J. FLUNDER, general purchasing manager of the Dunlop Group, is to become general manager of the chemical products division in Birmingham in succession to Mr. N. G. Bassett Smith who is to become general manager of the Dunlop Footwear Company at Walton, Liverpool. The appointments become effective on August 1.

MR. ST. JOHN DE H. ELSTUB has been appointed chairman of the metals division of Imperial Chemical Industries, Ltd., in succession to Mr. M. J. S. Clapham, who has joined the company's main board as an overseas director. Dr. William Henry George Lake has been appointed joint managing director (technical) of the metals division of I.C.I. in succession to Mr. St. J. Elstub.

CENTRAL ELECTRICITY GENERATING BOARD, MIDLANDS AND EAST MIDLANDS REGION, announces that the following appointments have been made in the newly created regional electrical department which will be responsible for all transmission construction work in the Region as well as the co-ordination of commissioning tests on protective gear, metering, communication equipment and system development: Mr. W. W. Smith, M.I.E.E., has been appointed regional electrical engineer; Mr. J. D. Pierce, M.I.E.E., has been appointed regional transmission project engineer; Dr. L. B. Wood, A.M.I.E.E., has been appointed regional technical and development engineer.

Business Announcements

THE BRITISH WAGON COMPANY, Ltd., has opened a new branch at Prudential Buildings, 59, St. Andrew's Street, Cambridge, (telephone, Cambridge 59636-7). Manager of the branch is Mr. D. Harding.

THOMAS BOLTON AND SONS, Ltd., announces that its sales office at Exchange Buildings, New Street, Birmingham, 2, has been closed, and the firm's north and south Midland area business has been transferred to 7, Market Street, Lichfield, Staffordshire (telephone, Lichfield 3632).

M. L. HOLDINGS, Ltd., states that through its subsidiary company M. L. Engineering (Plymouth), Ltd., it has entered into an agreement with L. M. Ericsson Signal-aktiebolag, a subsidiary of L. M. Ericsson of Sweden, for the sale and manufacture of railway signalling equipment in this country.

THE PLESSEY COMPANY, Ltd., Ilford, Essex, announces that a licence agreement has been concluded with Rini International, whereby Plessey will manufacture Rini thermal overload protectors and starting relays, with exclusive marketing rights in the United Kingdom and non-exclusive rights elsewhere except Italy.

BRUCE PEEBLES AND CO., Ltd., Edinburgh, states that an agreement has been concluded with REGA Brucker and Co., Siegburg, Germany, for the joint production and marketing of complete electrical equipments for the operation and control of ferrous and non-ferrous hot and cold rolling mills. Under the arrangements made in the agreement, which covers the supply of equipment in the whole of the United Kingdom and in Eire, rotating machines and rectifiers will be built by Bruce Peebles, and the electronic controls, programming, optimisation, and automatic gauge control equipment will be designed by REGA Brucker and manufactured either by them, or, under licence, by Bruce Peebles.

PYE, Ltd., Cambridge, states that a new electronics factory to be opened in Inverigo, Northern Italy, will be operated by a company to be called Pye Electronic S.p.A., with offices in Milan. Managing director of the new company is Mr. L. W. Jones, M.I.P.E., works director of the Pye Group of Companies. Selling, distribution and service arrangements will be under Dr. Giulio Falcinelli, and the technical manager will be Mr. C. K. Jones. It is expected that the Italian factory will become Pye's Common Market factory and will supply or manufacture television, radio, domestic appliances and electronic equipment. Other members of the board of Pye Electronic S.p.A. are Mr. L. G. Hawkins (President), Mr. J. O. Stanley, Mr. Victor Ercolani and Signor Freddie Barda.

Contracts

FITZPATRICK AND SONS (CONTRACTORS), Ltd., has been awarded a contract by Essex County Council, amounting to £376,632, for work on the improvement of New Road, Rainham, a section of the London–Tilbury Road (A.13), which will form part of one of the main approaches to the Dartford–Purfleet Tunnel.

J. ANDERSON AND KING, Ltd., has been awarded a contract for the improvement of 3¾ miles of road between Lesmahagow and Canderwater, Lanarkshire, on the Carlisle–Glasgow trunk road. The scheme is estimated to cost £798,000 and involves the provision of dual carriageways, slip roads, culverts, five road bridges, and other ancillary works. Messrs. Babtie, Shaw and Morton, Ltd., are consulting engineers to the Secretary of State for the scheme.

THE MITCHELL CONSTRUCTION COMPANY has been awarded a third contract by the Northern Project Group of the Central Electricity Generating Board, for civil engineering works at Blyth "B" Power Station, Northumberland. Its value is in the region of £720,000, and it covers foundations for turbo-alternators, boilers, main buildings, two chimneys, foundations for the switchgear, and transformer house, a circulating water pump-house and ancillary works.

THE FRASER AND CHALMERS ENGINEERING WORKS of THE GENERAL ELECTRIC COMPANY, Ltd., has received an order exceeding £150,000 from the Anglo-American Corporation of South Africa, Ltd., for two complete double-drum winding engines. The engines are for the main sub-incline shaft of Bancroft Mines, Ltd., Northern Rhodesia, and will be installed in an underground chamber approximately 1150ft below the surface. One of the winding engines will be employed for handling rock and the other for winding men and materials. The mechanical parts of the winders will be identical and each drum will be 11ft in diameter and 4ft wide, and the engines will be driven through single-reduction gears by 11kV, three-phase, 1440 h.p., 570 r.p.m. motors.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., will supply the largest cable it has made for commercial operation to the Hydro Electric Power Commission of Ontario. It is a single-core, 230kV cable with a 2·16 square inch conductor consisting of six stranded segments laid round a central oil duct, and has a reinforced lead alloy sheath and corrosion protection of self-vulcanising rubber, P.V.C. and hessian tapes. Reinforcing bronze tapes, tinned to prevent galvanic action between the bronze and the lead alloy, are applied over the lead alloy sheath. The cable will provide two three-phase circuits between Haig Junction and Applewood Junction in Toronto, each circuit being designed for operation at 230kV with a rating of 540MVA at 100 per cent daily load factor and 680MVA at 75 per cent daily load factor with the adjacent circuit out of service. The cables will be laid direct in the ground without ducts and, in anticipation of a possible future load growth and an increase in the current carrying requirements of the cable circuits, three ¾in internal diameter polyethylene water pipes will be installed with each circuit for cooling.

Miscellanea

SEMICONDUCTOR POWER RECTIFIER.—In our second reference to the current rating of the Mullard BYZ14 silicon diode on page 520 of our March 31 issue, the figure of 20A maximum average forward current was quoted incorrectly as 200A. Our apologies are due.

PASSENGER CAR MODIFICATIONS.—A number of modifications to the Citroen "DS" have been announced. The engine has been uprated to use premium fuel, the compression ratio rising from 7·5 to 8·5 and the power from 75 b.h.p. to 83 b.h.p., still at 4500 r.p.m. Weber carburetters are now exclusive, and a single coil and distributor replaces the twin coil ignition system. A Holset damper is now fitted to the crankshaft. The hydraulic clutch operation has been altered: on the original installation adjustment for rapid engagement during gear changes resulted in abrupt starts from rest. The final drive has been altered from 9 : 35 to 8 : 31, affecting the ratio insignificantly. A new design of fully reclining seat is now standard which is compatible with the optional Belbrace inertia lock safety harness.

Awards

THE MINISTRY OF AVIATION states that Mr. E. S. Calvert and Mr. J. W. Sparke, scientists at the Royal Aircraft Establishment, have been named winners of the 1961 Laura Taber Barbour Air Safety Award. They were specifically cited for their major contribution to world air safety through joint development of the Line and Bar Approach Lighting System and the Visual Glide Path Indicator.

THE INSTITUTION OF MECHANICAL ENGINEERS has awarded the 1960 James Clayton prize to Dr. William Ker Wilson, M.I.Mech.E., for his contributions to mechanical engineering science by way of theoretical investigation leading to practical solutions to many outstanding problems—including work on torsional vibration, general vibration, engine balance, crankshaft design, the special problems of vibration associated with aero gas turbines and gyroscopic loading on gas turbine rotors—and for his many technical papers and outstanding text-books.

CONTINENTAL AFFAIRS

by Our Continental Editor

Rourkela Steel Plant

UNDER the second Five-Year Plan, which ends this year, India is striving to achieve a steel production capacity of 6,000,000 tons per annum. In furtherance of this objective, three large steel plants have been under construction with the assistance of foreign countries, viz. Rourkela (Germany), Bhilai (U.S.S.R.), and Durgapur (Great Britain). On March 28, the Rourkela plant was officially inaugurated.

The Rourkela steelworks belong almost wholly to the government-owned Hindustan Steel Limited. They are situated near the village of Rourkela (population 140), in Orissa, approximately 450km west of Calcutta near the river Brahmani, below the confluence of its tributaries Sankh and Koel. For the new steel town a population of 100,000 is envisaged comprising 15,000 workers with 60,000 dependents, and 25,000 others. Rourkela relies for communication with the rest of the country on the still largely single-track Calcutta–Bombay railway. The situation was chosen on account of the nearby iron ore deposits with up to 60 per cent iron content. Unfortunately, coal has to be brought over a distance of 300km from mines lying to the north-west. Limestone and manganese are in adequate supply locally.

An agreement was concluded at the end of 1953 between the Indian Government and a German working group consisting of Fried. Krupp, Essen, and Demag A.G., Duisburg, for the latter to act as consultants. Subsequently, the group supervised the construction, and together with some thirty other principal contractors supplied plant and equipment. The installations comprise blast furnaces, a steel plant and rolling mill. Total consignments from Europe exceeded 360,000 tons, with individual items weighing up to 165 tons.

Blast Furnace Plant.—There are three blast furnaces, each of a daily output capacity of 1000 tons. The first of these, shown under construction in Fig. 1, was blown in in 1959. Built by Gutehoffnungshütte Sterkrade A.G. (GHH), Oberhausen, the furnaces are of American design, with a hearth diameter of 7·4m, a height of approximately 30m from the hearth bottom to the charging platform, and a working volume of approximately 1000 cubic metres. Total height above the mill floor is about 65m. Each furnace has one iron taphole and two slag notches. Platforms at notch level are roofed. Iron is tapped into 80-ton ladles which are taken on cars to the steel works or the pig casting machine ; the slag is dumped.

Each furnace is provided with three hot blast stoves, each 8m in diameter and 37m high and representing a heating area of approximately 34,000 square metres. Total rating is 140,000 cubic metres of blast per hour heated to up to 950 deg. Cent.

At each furnace there is a lift up to the throat level for materials and personnel. Walkways interconnect the blast furnaces, hot blast stoves and bunkers.

The double-strand inclined skip hoist is fully automatic and is operated from the control stand. The hoist winch, two bell winches, and three stock-line gauge rod winches are located in an engine room above the bunker plant. After a predetermined number of skip journeys the hopper is rotated through an angle in order to spread the charge evenly. The various operations (discharging of the coke weighing hoppers and of the scale car, skip travelling, hopper rotation, bell lowering and raising) are interlocked and follow each other in automatic sequence, with alternative manual operation provided.

As far as possible, the ore which comes from the mine already graded is charged directly into the furnace bunkers, and the same applies to the coke from the coke ovens. However, a buffer storage space for ore and oven coke has been provided and is served by a bridge of 45m span and 20-ton capacity, equipped with a 3·5 cubic metres grab for ore and one of 8 cubic metres for coke. The coke arrives on a 1200mm wide roofed conveyor ; the grabs discharge into wagons. Each furnace has sixteen ore bunkers holding enough ore for at least three days, while the coke bunkers hold enough for half a day. Materials from the bunkers are discharged into a scale car with two 6 cubic metre weighing compartments, and from them into the buckets of the skip hoist. There are three scale cars, one for each furnace, together with a stand-by car ; their travelling speed is about 150m per minute.

The 2400 ton per day pig casting machine

Fig. 2—Four-high stand for plate mill, during assembly at the maker's works. The stand has a height of 14m, with rolls 3·1m long, and is served by two 30m-long roller tables

Fig. 1—Blast-furnace plant, with first blast furnace nearing completion (November, 1958)

incorporates 760 moulds, each holding 50 kg of metal, which travel on two 55m-long strands at 5 to 12m per minute. Other GHH equipment at Rourkela includes four turbine-driven twin radial blast furnace blowers (one a stand-by). Each is rated at 6700kW, 3570 r.p.m., and gives an output of 165,000 cubic metres per hour at 2·73 atmospheres absolute. There are a 3MW back pressure turbine for a generator set, for the oxygen plant three turbo-compressors, each rated at 40,700 cubic metres per hour at 6 atmospheres absolute ; and two flow compressors. Noteworthy for their size are the five screw compressors for coke oven gas, which are three-stage machines rated at 23,000 cubic metres per hour at 15 atmospheres abolute delivery pressure. Mention may also be made of the 20-ton erection derricks employed by GHH, with 78m high masts and 36m jibs (Fig. 1).

Siemens-Martin and LD Oxygen Steel Works.—Supplied by Fried. Krupp, Essen, and the VOEST, Linz (Austria), the steel plant annually converts 102,000 tons of pig iron and 160,000 tons of scrap into 250,000 tons of steel. There are two 1100-ton mixers, four 80-ton SM furnaces, the first of which was commissioned in the summer of 1959, and three 40-ton LD converters.

Foundry.—The grey iron foundry has an annual capacity of 40,000 tons and supplies the needs of the plant for ingot moulds, &c.

Rolling Mill.—A total rolling capacity of 720,000 tons per annum is provided, including 200,000 tons per annum of plate up to 3·1m wide and 10mm to 38mm thick (Fig. 2). A semi-continuous broad strip mill with two reversing cold-rolling stands has been installed.

Fertiliser Plant.—It is planned to add a plant for producing annually 600,000 tons of calcium ammonium nitrate from surplus coke oven gas, nitrogen, and lime.

Township.—In order to house the workers and their families, as well as the people serving this population, a town for 100,000 is being set up in an area of 1500 hectares north of the works. Separated from the noise and smoke by a range of low hills, the town, which is being built by a Krupp subsidiary, will be divided into twenty wards, each with 5000 inhabitants. Connection between the different parts of the town, as well as with the steelworks and the railway station, is formed by a large ring road. The water supply for the town, as well as for the steelworks, comes from a seasonal reservoir on the river Sankh.

150-ton Floating Crane

BUILT by Krupp-Ardelt G.m.b.H., Wilhelmshaven, the 150-ton floating crane "El Gabbar" has now been delivered to the owner, Ports and Lighthouses Administration, Alexandria. The crane (Fig. 1) has a level-luffing jib of box-section fabricated members. This design is stated to save weight as compared with the traditional lattice construction, and thereby contributes to increasing the stability. The same purpose has been served by placing the movable counterweight as low as possible consistent with space considerations, i.e. directly above the hoist machinery compartment. The counterweight is hinged to the "A"-frame, and is joined by a tie-bar to a balance beam situated at the top of the frame, the beam in turn being linked to the jib.

The lower part of the "A"-frame surrounds the octagonal support column which is rigidly mounted on the pontoon and about which the whole crane can revolve fully laden through 360 deg.

The pontoon is 49·5m long and has a beam of 20m and a draught of 2·25m, with 1·95m freeboard. Lifting capacity is 150 tonnes at 20m radius reckoned from the slewing centre, which is equivalent to a maximum distance of 10m from the side. At 30m radius the crane can lift 70 tonnes to a height of 25m above the water, while the auxiliary hook can raise 30 tonnes to a height of 28m at 32m radius. The main hook can be lowered 10m into the water. The maximum heel angle is approximately 5 deg.

As it is intended to use the crane in a number of ports it must be possible to move or tow it safely over long distances even in bad weather. For such voyages the jib is lowered on to the deck by means of the telescopic level-luffing spindle, and made fast.

At the bottom of the "A"-frame is the hoist machinery platform which is completely enclosed. Higher up, approximately 10m above the water line, is the enclosed panoramic driving cabin.

In the engine-room of the pontoon (Fig. 2) are stationed two four-stroke diesel engines of 500 h.p. each, which are directly coupled to two Voith-Schneider propellers situated in diagonally opposite corners of the pontoon. These give the craft a speed of four to five knots, and enable it to turn almost on the spot.

Two main generators of 90kW each are directly coupled to the diesel engines. In addition there are two auxiliary diesel-generating sets of 156 h.p./90kW with coupled air compressors. A 46 h.p./25kW generating set supplies current for lighting when the crane is not in operation. The voltage for the crane motors is 440V d.c. and that of the ship's mains 220V d.c. Two-way communication equipment connects the wheelhouse, crane cabin, hoist compartment, and pontoon.

The crane's slewing time can be varied between six minutes and sixty minutes for a full turn, while the level-luffing time between maximum and minimum radius is nine minutes to ninety minutes. An electro-mechanical indicator shows the driver the actual load radius, i.e. the jib radius corrected for heel. An electronic limiting device protects the crane from overloads. Constant level-luffing speed is automatically maintained by a controller linked to the jib.

Much attention has been paid to the accommodation of the nineteen members of the crew. The air-conditioned galley is equipped with an electric cooking range, refrigerator, and hot and cold water supply. The crane has its own workshop with bench for two fitters, grinder and drill press, lathe, and motor-generator welding set.

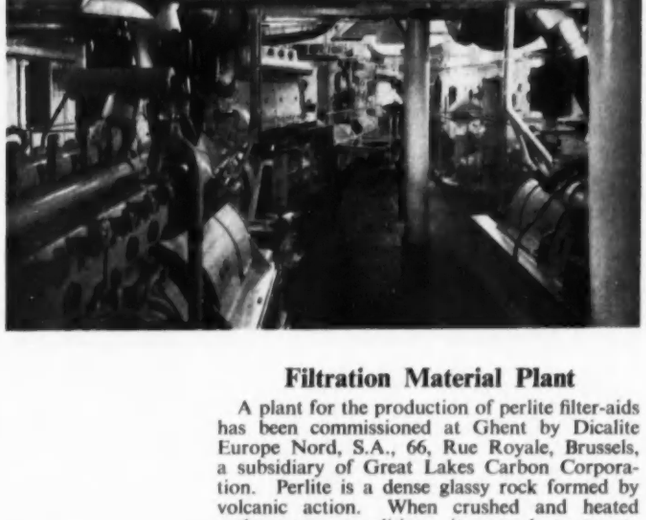


Fig. 2—View of the engine-room inside the pontoon

Fig. 1—Level-luffing floating crane with box-section jib construction. It can lift 150 tonnes at 20m radius from slewing centre ; its maximum radius is 32m

Filtration Material Plant

A plant for the production of perlite filter-aids has been commissioned at Ghent by Dicalite Europe Nord, S.A., 66, Rue Royale, Brussels, a subsidiary of Great Lakes Carbon Corporation. Perlite is a dense glassy rock formed by volcanic action. When crushed and heated under proper conditions, it expands to twenty or more times its original volume. Further treatment produces a mass of irregular fragmented particles which interlock to form a virtually incompressible filter cake of 80 to 90 per cent void space, capable of screening particles of less than 1 micron in size. It is claimed that with "Dicalite" perlite as a filter-aid it is possible in many cases to use 25 per cent less material than with conventional diatomaceous earth, without any reduction in filtering capacity. In addition, it is stated to be highly efficient in filtering liquids containing a high percentage of dispersed solids, and to be remarkably resistant to cracking when applied as a pre-coat on rotary vacuum filters. It is very inert, insoluble except in strong acids and alkalis, tasteless and odourless. "Dicalite" perlite filter-aids are marketed in the United Kingdom by F. W. Berk and Co., Ltd., Berk House, 8, Baker Street, London, W.1.

THE AMERICAN SCENE

By Our American Editor

Superconducting Wire Solenoids for Ultra-high Magnetic Fields

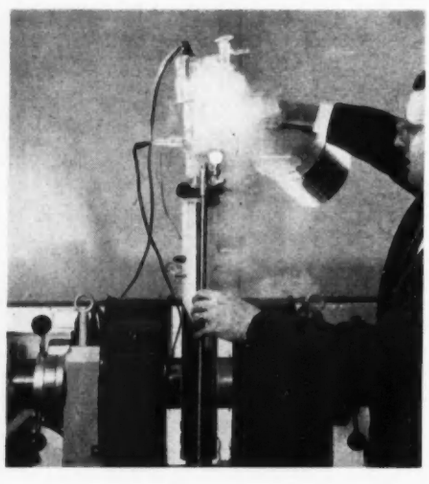
THE Bell Telephone Laboratories, at Murray Hill, New Jersey, recently demonstrated the feasibility of super-conducting solenoid magnets producing extremely high magnetic fields. The work utilised a superconducting compound of niobium and tin (Nb_3Sn), fabricated and reacted by special metallurgical techniques. Although it has been realised for many years that it is possible to produce magnetic fields with superconducting solenoids, the materials that have been tried in the past would only sustain fields of a few thousand gauss. At larger magnetic fields the superconducting properties disappear. With the new compound, steady-state magnetic fields of 88,000 gauss are possible.

Nb_3Sn becomes superconducting at 18 deg. Kelvin, representing a higher transition temperature than that of any other known superconductor. This compound was first discovered at the Bell Telephone Laboratories in 1954. Until the present, however, its critical field had not been measured. Since the material is extremely brittle, it was hitherto impossible to use the niobium-tin compound in the construction of a solenoid.

Present indications are that the niobium-tin material will sustain fields of 100,000 gauss while carrying electrical currents of 100,000A per square centimetre of cross-section. This new advance in the field of cryogenics resulted from new metallurgical arts, together with experimental and theoretical knowledge of the physics of solids. The unusual behaviour of Nb_3Sn at high fields raises many questions about the nature of superconductivity. The new material will have important applications wherever large volumes of magnetic fields are required. Important applications in the field of communications are envisaged. Another attractive application is the containment of thermonuclear fusion plasmas for the production of electric power. A third important area is in the experimental physics laboratory.

To illustrate the simplification in magnet design that this new development will make possible, a superconducting electromagnet can be compared to a more conventional magnet using copper as the conductor. Such a conventional magnet presently in operation at the Bell Telephone Laboratories requires a power supply and cooling equipment which literally fills several rooms. While in operation it uses thousands of gallons of cooling water per hour and consumes 1·5MW of electric power. By contrast, a superconducting solenoid magnet of Nb_3Sn, and producing a comparable field, would not consume any electric energy once the flux was established.

The phenomenon of superconductivity was discovered by the Dutch physicist, Kamerlingh Onnes in 1911. He found that the electrical resistance of some metals disappeared at very low temperatures and that below these transition temperatures the metals could carry electrical current without dissipating energy. Although many possible applications of this phenomenon were immediately apparent for several decades, this discovery was not put to practical use for many reasons. The very low temperatures required has made it impractical to consider the use of superconductors in such obvious places as wire-linked communications or the transmission of electrical power. A second possible application that was considered shortly after the discovery was the construction of electromagnets made of superconductors which would not require any electrical energy to maintain the magnetic field once it was established. Unfortunately, it was soon discovered that superconductivity was not compatible with high magnetic fields. In the materials studied by Kamerlingh Onnes and succeeding investigators, it was found that superconductivity would disappear in the presence of magnetic fields greater than a few thousand gauss, that the metal would then become a normal conductor and the flow of electrical current would dissipate energy. In 1941 Justi published studies of a superconducting solenoid which produced small magnetic fields. It was not until 1960 that a new attempt to produce a magnetic field with a superconductor was reported by S. H. Autler who obtained fields of 4300 gauss. This work further emphasised that in order to extend the use of superconducting magnets into many important areas, a material was required which would retain its superconducting properties in high magnetic fields. Investigators at the Bell Telephone Laboratories have now found that Nb_3Sn has these properties.



Pouring of liquid nitrogen into cryostat apparatus to super-cool niobium-tin compound for producing an ultra-high magnetic field

The metal niobium was considered a rare element until about ten years ago. New discoveries of ore now indicate that it is about as abundant as nickel, and niobium is being extensively studied as an alloying element in structural materials for high temperature applications such as in rocket motors. In 1954, while searching for new superconducting compounds, B. T. Matthias, T. H. Geballe, S. Geller, and E. Corenzwit of the Bell Laboratories Research Department predicted that a compound of niobium and tin should be superconducting and possess a high transition temperature. They discovered that niobium and tin reacted readily with each other to form the compound Nb_3Sn which had a transition temperature of 18 deg. Kelvin, the highest temperature known at present. In 1960, R. M. Bozorth, D. D. Davis, and A. J. Williams of Bell measured the magnetic susceptibility of Nb_3Sn and found evidence that traces of superconductivity existed in magnetic fields up to 70,000 gauss.

Although many uses for this unusual material seemed evident, its metallurgical properties delayed practical application. The principal reason for this is that the material is very brittle. Thus, although the high critical temperature did suggest that the critical field would also be high, there was no obvious way to fabricate a wire form of the material which could be used to build a superconducting solenoid. The latest work at the Bell Laboratories by J. E. Kunzler, E. Buehler, F. S. L. Hsu, and J. H. Wernick has not only conclusively shown that the critical field is extremely high but has also resulted in the development of metallurgical processes which solve the fabrication problem. These investigators studied the properties of bars of the brittle Nb_3Sn cut from an ingot of the compound which was formed by melting niobium metal and tin metal together at about 2400 deg. Cent. They found that the bars were superconductors; they had zero electrical resistance in magnetic fields up to 88,000 gauss. Furthermore, in these high fields the bars could carry electrical currents of up to 3000A per square centimetre at a temperature of 4·2 deg. Kelvin (the boiling point of liquid helium), without heating or using up energy in any way.

Then they went to work to discover a way to circumvent the mechanical brittleness of Nb_3Sn in order to be able to use these unusual properties. They started with a niobium tube of $\frac{1}{4}$in o.d. and about $\frac{1}{16}$in i.d. This tube was packed with a mixture of powdered niobium metal and powdered tin in the ratio of approximately 3 to 1. Since niobium and tin are ductile metals before they are reacted, it was possible to seal the ends of this tube with Nb plugs and mechanically reduce the tube by swaging and drawing to a wire 0·015in in diameter. This wire is now very ductile and can easily be wound into a solenoid coil. However, it still has the properties of the individual metals and is not useful for producing high magnetic fields. But once the coil is wound, if the wire is heated to about 1000 deg. Cent., the powders inside react to form the compound Nb_3Sn, and the resulting structure has excellent superconducting properties in high magnetic fields.

Indeed, it was found that the compound formed in this way inside a niobium tube has better properties for high magnetic fields than an ingot of Nb_3Sn formed by melting the metals together at 2400 deg. Cent. In the wire form the Nb_3Sn is superconducting in fields of 88,000 gauss while carrying currents of over 150,000A per square centimetre. These current densities are fifty times larger than the current densities the ingot material can carry. Although the available laboratory facilities did not permit measurements at fields above 88,000 gauss, the present data indicate that these properties should extend to 100,000 gauss and possibly higher. The current theoretical understanding of the phenomenon of superconductivity does not provide a full explanation of these recent findings. Indeed, these results may stimulate further evolution of theoretical knowledge in this area of solid state physics. A large solenoid has not yet been constructed from this unique material. The mechanical forces produced by magnetic fields of 100,000 gauss present engineering problems of construction. The solution of these problems are straightforward, but it will probably be about a year before a large device is constructed.

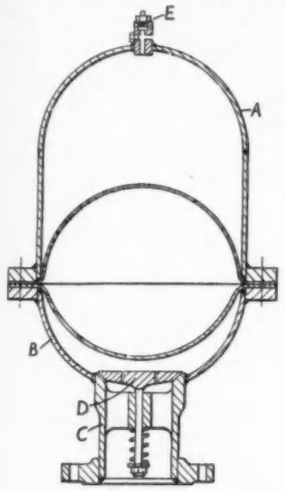
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

HYDRAULIC EQUIPMENT

862,303. February 13, 1959.—SHOCK ALLEVIATORS, British Petroleum Company, Ltd., Britannic House, E.C.2, and Peter Gillingham Williams, of the Company's address.

This invention relates to shock alleviators in which a liquid containing compartment surrounds a flexible bag containing a buffer gas. This known type of alleviator has a valve or other means for introducing gas into the bag and a port through which the liquid passes into the compartment while a high-pressure condition is being alleviated and through which this liquid subsequently returns when the high-pressure condition has ended. These shock alleviators have a disadvantage in that the liquid returning through the port can set up a subsidiary high-pressure condition, leading to a pressure pulsation effect in the main body of liquid. The alleviator described has a restricted passageway by which fluid, trapped in the container by the closure of the valve, is slowly vented in a simple manner back into the fluid containing system. In this manner the fluid is returned without setting up a new high-pressure condition, thus avoiding the oscillations of pressure. The alleviator which may be employed for the control of gases or liquids is particularly suitable for use in the control of aviation fuels during the fuelling of aircraft. It is illustrated in the drawing. A rigid container consists of an upper shell *A* flanged to a lower shell *B*, the lower



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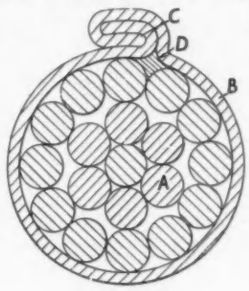
shell being integral with a pipe *C* which, at its upper end, provides a seat for valve *D*. The valve is loaded to the closed position by a light spring and has six small holes through the head. The upper shell carries an air valve *E* for the attachment of a pressure gauge (not shown). A perforated dished rigid support plate and a dished flexible elastic diaphragm are fixed between the shell flanges and the upward movement of the diaphragm is limited by the support plate. The alleviator may be connected by the pipe *C* to a fluid containing system, for example, by "T" pipe to a fuelling line. In the event of a rapid build-up in pressure in this system, fluid pressure will cause the valve to lift and fluid will flow into the container, causing the diaphragm to rise and compressing the gas in the upper part of the container. When the fluid flow diminishes the valve closes and the fluid in due course slowly returns to the system via the small holes in valve head.—*March* 8, 1961.

TELECOMMUNICATIONS

863,436. August 15, 1958.—ELECTRIC SUBMARINE CABLES, Standard Telephones and Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2. (*Inventor: Hayden Albert Moore.*)

A submarine cable of the coaxial conductor type is known in which the central conductor consists of stranded metal wires around which is a copper tape applied in overlapping helical turns. It is also known to apply the copper tape longitudinally with the edges formed into a continuous box seam. The dielectric separating this central conductor from an outer conductor is a solid dielectric such as polythene applied by extrusion. Difficulty has arisen in the extrusion process because air in the interstices between the strands expands as a consequence of the heat in the extruder and forms air bubbles in the dielectric. According to the present invention a submarine cable comprises a central core of stranded metal wires, a copper tape wrapped longitudinally thereabout with a longitudinal seam, a filament of plastic material sealing hermetically the seam of the tape, solid dielectric surrounding the seamed copper tape and an outer conductor surrounding the dielectric. The drawing shows a cross section of a core of a



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submarine cable according to the invention. This core consists of a strand *A* of metal wires surrounded by a copper tape *B* folded longitudinally about the strand with the meeting edges formed into a box seam *C*. According to the present invention the meeting edges of the box seam are sealed by means of a filament *D* of plastic material, which has been heated to cause it to flow between the meeting edges of the box seam and so seal the seam. The polythene filament may be led through a tube so that it is applied immediately under the meeting edges of the copper tape *B* as the box seam is formed. The core shown in the drawing was formed with a strand of nineteen mild steel wires and the polythene filament *D* was 0·03in in diameter. This core formed the inner conductor of a submarine coaxial cable and a dielectric of polyethylene was extruded around this core. The core was heated in the usual manner at the entry to the extrusion machine by means of gas flames and the heat so applied caused the polyethylene of the filament to flow between the meeting edges of the box seam and between the conductors adjacent to the box seam and the copper tape *B* thus hermetically sealing the metal strands within the copper tape. With such a construction the difficulties formerly occurring have been overcome and no air bubbles have been formed in the surrounding dielectric.—*March* 22, 1961.

862,432. November 15, 1957.—TUNING SYSTEM FOR VELOCITY MODULATION TUBES, Standard Telephones and Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2 (Communciated by International Standard Electric Corporation, 67, Broad Street, New York 4, New York, U.S.A.)

The present invention relates to tuning arrangements for resonators associated with electron velocity modulation tubes, and is particularly concerned with the tuning of such resonators having a tubular reentrant inner wall portion, such as a drift tube member, surrounding the electron beam. An annular non-contacting tuning piston is built into the resonator. Where it is desired to couple a wave feeder to the resonator, the invention enables variation of the impedance match between feeder and resonator to be minimised by arranging that the feeder is coupled to the resonator by an opening in the resonator wall which is, at least in part, covered by a skirted portion of the tuning piston. The invention facilitates the ganged tuning of the several resonators of a multi-resonator klystron, each of the tuning pistons being driven via a control rod from one of a set of control shafts which may be locked together after individual trimming adjustment of the tuning pistons.—*March* 8, 1961.

MACHINE TOOLS

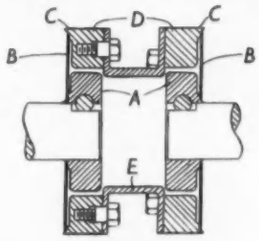
862,752. October 14, 1958.—CONTROLLING MACHINING OPERATIONS, Thomas Mercer, Ltd., Eywood Road, St. Albans, Hertfordshire, and David James Weatherby, Mount Ash, Mount Avenue, Hutton, Essex.

This invention relates to apparatus for automatically controlling component machining, the device utilising pneumatic means for sensing and electrical means for signalling the transient dimensions of the workpiece. The apparatus has in a pneumatic sensing means a main inlet supplied with compressed air and two branch circuits leading through restrictive orifices to outlets. One outlet is adapted to be partially restricted by a master setting device and the other by the workpiece being machined. Electrical switches are connected to the two branch pneumatic circuits between their respective orifices and outlets. When the master and the workpiece differ in dimension a pressure unbalance occurs between the two branch circuits, but as the work and the master become more nearly identical the pressure unbalance decreases towards zero. At or about zero differential pressure the contacts of the pressure operated switches signal that the work is of substantially similar dimension and the signals actuate controls regulating the feed of the machine. An advantage of the arrangement is that it eliminates the possibility of error due to unintentional change in the pressure of the compressed air supply. It also enables the sizes of individual workpieces to be controlled in accordance with reference workpieces, e.g. to "match" a shaft to a hole, where the "holes" are in workpieces previously manufactured and may vary within sensible limits from a given mean size, without resetting the apparatus. This function enables "match grinding" to be achieved automatically. An embodiment of the invention is described by way of example with reference to the drawings in the specification.—*March* 15, 1961.

POWER TRANSMISSION

861,599. May 1, 1958.—FLEXIBLE COUPLINGS, Courtaulds, Ltd., 16, St. Martin's-le-Grand, London. (*Inventor: John Irving Meldrum.*)

The coupling shown transmits power between two shafts, each of which has a collar *A* secured against



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rotation by a cotter pin engaging a flat on the end of the shaft. The outer face of each collar has a central shoulder or boss at its inner periphery and a flexible centrally apertured disc *B* of metal 0·018in thick and 3½in outside diameter is brazed to the face of the boss. The outer periphery of this disc is brazed to the face of a shallow flange *C* on an annular member *D*. The two members *D* are joined together to form a short torque tube as shown, by an annular channel member *E* which is secured to each by screws. The screws can be withdrawn and the channel removed to disconnect the coupling without interfering in any way with the shafts and leaving sufficient space for the removal of the parts.—*February* 22, 1961.

RUST REMOVAL

863,117. February 5, 1958.—CLEANING METALS, Imperial Chemical Industries, Ltd., a British Company, of Imperial Chemical House, Millbank, London, S.W.1. (*Inventor: Richard Elliott Shaw.*)

This invention provides a process of removing rust from ferriferous surfaces by treating the articles with an aqueous solution in which the rust-removing ingredients consist of at least 70 per cent by weight of alkali metal hydroxide and 3 per cent by weight of an organic additive chosen from the group of trialkanolamines, inositols, polyhydroxy alcohols derived from tetroses, pentoses, hexoses and heptoses, and mono- and di-carboxylic acids derived from tetroses, pentoses, hexoses, and heptoses, and water-soluble salts thereof. For best results the process is operated at an elevated temperature, at least 70 deg. Cent., and preferably just below the boiling point. In a preferred form of the process the rust removing solution contains at least 5 per cent by weight of the additive and 15 per cent by weight of sodium hydroxide. Gluconic acid and its sodium salt are particularly useful additives. Concentrates suitable on dilution with water for use in this invention may be made up as strong solutions containing alkali metal hydroxide, together with the organic additive, or as powders. Preferred concentrates contain at least 35 per cent sodium hydroxide and 15 per cent of the organic additive. The concentrates are stable and a particularly suitable form in which the basic ingredients for the rust-removing solutions may be transported.—*March* 15, 1961.

Catalogues and Brochures

HADFIELDS, Ltd., East Hecla Works, Sheffield, 9.—Publication No. 463, "Fine Steels," giving details of the Company's production capacity and the types and sizes of steel made. Tables of steels, with details of chemical composition and physical properties are given. Illustrated brochure.

HUNTINGTON, HEBERLEIN AND CO., Ltd., 28–29, Dover Street, London, W.1.—Illustrated brochure entitled "Regulation and Proportioning of Raw Materials for Sinter Plants." Illustrations and details are given of modern sinter plants at home and abroad, and a typical control system is described.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ANTIQUARIAN HOROLOGICAL SOCIETY

Sat., April 22.—Chartered Auctioneers' and Estate Agents' Institute, Regent House, St. Philip's Place, Colmore Row, Birmingham, 3, "Escapements for Clocks," W. J. Gazeley; "A Tour of My Own Collection," Bernard Hawkins, and "The Works of Peter Litherland of Liverpool," R. Vaudrey Mercer, 2 p.m.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, April 14.—STOKE AND CREWE BRANCH: Royal Hotel, Crewe, Films Evening, 7.30 p.m.

Mon., April 17.—BRISTOL AND WEST OF ENGLAND BRANCH: Royal York Hotel, Bath, "Electricity in Printing," B. I. O'Donnell, 8 p.m.

Tues., April 18.—I.E.E. Lecture Theatre, Savoy Place, London, W.C.2, Discussion on "Aspects of the Design of Electrical Installation Materials and Equipment," 6.30 p.m. ★ OXFORD AND DISTRICTS BRANCH: Employment Exchange, Oxford, "Fault Tracing in Electrical Apparatus," 8 p.m. ★ WEST KENT BRANCH: Coniston Hotel, Sittingbourne, "Fire Fighting," H. E. Evans, 7.30 p.m.

Wed., April 19.—WOLVERHAMPTON AND DISTRICT BRANCH: Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "Resistance Welding," H. Shurley, 7.45 p.m.

BRITISH HYDROMECHANICS RESEARCH ASSOCIATION

Mon. to Wed., April 17 *to* 19.—Grosvenor Hall, Conference Centre, Ashford, Kent, International Conference on "Fluid Sealing."

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., April 19.—MEDICAL ELECTRONICS GROUP: University College Medical School, University Street, Gower Street, London, W.C.1, "Instrumentation for Obstetrics," C. N. Smyth 6 p.m. ★ WEST MIDLANDS SECTION: Electrical Engineering Department, The University, Birmingham, Annual General Meeting, and Technical Films, 6.15 p.m. ★ SOUTH WESTERN SECTION: School of Management Studies, Unity Street, Bristol, "Colour Television," G. N. Patchett, 7 p.m. ★ MERSEYSIDE SECTION: Adelphi Hotel, Liverpool, "The History of Radio," G. R. M. Garratt, 7 p.m. ★ SOUTHERN SECTION: Lanchester Buildings, The University, Southampton, "The Development of an Ammonia Maser Oscillator as a Frequency Standard," A. Mitchell, 7 p.m.

Fri., April 21.—SOUTH MIDLANDS SECTION: North Gloucestershire Technical College, Cheltenham, Annual General Meeting, and "The Mesa Transistor and its H.F. Applications," D. H. Mehrtens, 7 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., April 17.—LEEDS CENTRE: British Lighting Council, 24, Aire Street, Leeds, 1, "The Artistic Use of Lighting in Multi-Camera Technique," N. E. H. Mayhew, 6.15 p.m.

Tues., April 18.—LIVERPOOL CENTRE: Electrical Industrial Development Centre, Merseyside and N. Wales Electricity Board, Paradise Street, Liverpool, 1, Annual General Meeting, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Mon., April 17.—EAST ANGLIAN SECTION: Lecture Hall, Public Library, Ipswich, Annual General Meeting, and L. J. Tibbenham Award (Short Paper) Competition, 7.30 p.m.

Wed., April 19.—LONDON BRANCH: Constitutional Club, Northumberland Avenue, London, W.C.2, Annual General Meeting and Apprentices' Evening, 7 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., April 18.—Memorial Building, 76, Mark Lane, London, E.C.3, "Corrosion of Tin-Base Babbitt Bearings in Marine Steam Turbines," J. B. Bryce and T. G. Roehner, 5.30 p.m.

Wed., April 19.—NORTH MIDLANDS SECTION: School of Art, Green Lane, Derby, "Distillation for Marine Purposes," W. R. Stewart, 7.15 p.m.

INSTITUTE OF METALS

Thurs., April 20.—LIVERPOOL METALLURGICAL SOCIETY: Department of Metallurgy, The University, Liverpool, "Continuous Casting of Aluminium Alloys," W. M. Doyle, and Annual General Meeting, 7 p.m.

Fri., April 21.—WEST OF ENGLAND METALLURGICAL SOCIETY: College of Technology, Ashley Down, Bristol, 7, "Temperature Measurement," J. A. Hall, 7.30 p.m.

INSTITUTE OF NAVIGATION

Fri., April 21.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Marine Radar Presentation," S. R. Parsons and F. J. Wylie, 5.15 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, April 14.—SOUTH EASTERN CENTRE: Wig and Gown Hotel, Maidstone, Kent, Annual General Meeting, 7.30 p.m.

Tues., April 18.—MIDLANDS CENTRE: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, Annual General Meeting, 7.30 p.m.

Wed., April 19.—EAST MIDLANDS CENTRE: Mechanics' Institute, Nottingham, Annual General Meeting, 7.30 p.m.

Thurs., April 20.—YORKSHIRE CENTRE: Great Northern Hotel, Wellington Street, Leeds, 1, Annual General Meeting, 7.30 p.m. ★ METROPOLITAN AREA: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Automotive Transmission Lubrication," W. A. Patrick, 6.30 p.m.

Mon., April 24.—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, Annual General Meeting, 7.30 p.m.

INSTITUTION OF AGRICULTURAL ENGINEERS

Tues., April 25.—Piccadilly Hotel, London, W.1, Annual General Meeting and One-day Conference, 10.30 a.m. and 2.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Wed., April 19.—NORTH WESTERN BRANCH: Grosvenor Museum, Chester, "Some Corrosion Problems in the Chemical Industry," D. Bennion, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., April 18.—Great George Street, Westminster, London, S.W.1, "The Use of Specialised Plant on Airfield and Road Construction," E. U. Broadbent and M. A. May, 5.30 p.m.

Thurs., April 20.—TRAFFIC ENGINEERING STUDY GROUP: Great George Street, Westminster, London, S.W.1, Discussion on "Traffic Planning and Design of Roads in Cumbernauld New Town," introduced by G. P. Crow, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Sat., April 15.—LONDON GRADUATE AND STUDENT SECTION: Visit to Independent Television Authority, Croydon, 7.30 p.m.

Mon., April 17.—INFORMAL MEETING: Savoy Place, London, W.C.2, Discussion on "The Education of Engineers—All's Well," opened by Sir Hamish D. MacLaren, 5.30 p.m. ★ NORTH EASTERN CENTRE: Royal Station Hotel, Newcastle upon Tyne, Annual General Meeting and Conversazione, 6.30 p.m. ★ SCOTTISH ELECTRONICS AND MEASUREMENTS GROUP: Royal College of Science and Technology, Glasgow, Annual General Meeting, and "Hydraulics *v.* Electrics," D. Firth, 6 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Duncan Hall, Stone, Staffs., "The Potentialities of Artificial Earth Satellites for Radiocommunication," W. J. Bray, 7 p.m. ★ SOUTHERN CENTRE: Technical College, Brighton, "Progress in Oil-Filled Cables and their Accessories," A. N. Arman, F. J. Miranda, and G. R. Bishop, and "The Influence of Ageing on the Characteristics of Oil-Filled Cable Dielectrics," P. Gazzana-Priaroggia, G. L. Palandri and U. A. Pelagatti, 6.30 p.m. ★ WESTERN SUPPLY GROUP: South Wales Institute of Engineers, Park Place, Cardiff, "The Operation of Large Electrical Supply Systems," L. B. Law, 6 p.m.

Tues., April 18.—NORTH MIDLAND UTILISATION GROUP: Leeds and County Conservative Club, South Parade, Leeds, 1, "The Application of Irradiation in Industry," M. C. Crowley-Milling, 6.30 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE: Carlton Hotel, Edinburgh, "Radiocommunication in the Power Industry," E. H. Cox and R. E. Martin, 7 p.m. ★ SOUTHERN CENTRE: Technical College, Farnborough, Joint meeting with the Royal Aeronautical Society, "The Future of 'Electrics' and 'Electronics' in Aircraft and Guided Missiles," The Rt. Hon. The Viscount Caldecote, 6.15 p.m.

Wed., April 19.—SUPPLY SECTION: Savoy Place, London, W.C.2, "Progress in Oil-Filled Cables and their Accessories," A. N. Arman, F. J. Miranda, and G. R. Bishop, and "The Influence of Ageing on the Characteristics of Oil-Filled Cable Dielectric," P. Gazzana-Priaroggia, G. L. Palandri and V. A. Pelagatti, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Visit to Port of London Authority, Thames Navigation Service Building, Gravesend, 3 p.m. ★ SHEFFIELD SUB-CENTRE: North Lindsey Technical College, Scunthorpe, "Silicon Power Rectifiers," A. J. Blundell, A. E. Garside, R. G. Hibberd and I. Williams, 6.30 p.m.

Thurs., April 20.—UTILISATION SECTION: Savoy Place, London, W.C.2, Joint meeting with the London Graduate and Student Section; "Aluminium in Electrical Engineering," P. J. H. Rata; "Diesel Railway Locomotives," A. D. Swanston and B. W. Towell, and "Automatic Programming for Hot Reversing Mills," T. E. S. Rickard, 6 p.m. ★ CAMBRIDGE ELECTRONICS AND MEASUREMENT GROUP: Cavendish Laboratory, Cambridge, "The Potentialities of Artificial Earth Satellites for Radiocommunication," W. J. Bray, 8 p.m.

Sat., April 22.—LONDON GRADUATE AND STUDENT SECTION: Visit to St. Bartholomew's Hospital, High Voltage X-Ray Therapy Department, 10.30 a.m.

Mon., April 24.—EAST ANGLIAN SUB-CENTRE: Electric House, Ipswich, "A Basis for Short-Circuit Ratings for Paper-Insulated Cables up to 11kV," L. Gosland and R. G. Parr, 6.30 p.m. ★ SOUTH MIDLAND ELECTRONICS AND MEASUREMENT GROUP: James Watt Memorial Institute, Birmingham, Annual General Meeting, and "A Review of Progress in Ultrasonic Inspection Techniques," A. C. Rankin, 6 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., April 19.—YORKSHIRE BRANCH: Visit to F. E. Fox and Son, Ltd., Wellington Street, Batley, 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., April 18.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting, and "Work Study and its Application to Motive Power Activities," G. O. B. Clarke and W. G. F. Thorley, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, April 14.—NORTH EASTERN GRADUATES' SECTION: Rutherford College, Newcastle upon Tyne, Annual General Meeting, and "Turbine Developments," J. Burt, 6.30 p.m.

Sat., April 15.—SOUTHERN GRADUATES' SECTION: Visit to Kearney and Trecker—C.V.A., Ltd., Hove, Sussex, 10 a.m.

Tues., April 18.—ORDINARY MEETING: Chemistry Lecture Theatre, The University, Leeds, "Influence of Rate of Strain-hardening in Machining," P. L. B. Oxley, A. G. Humphreys and A. Larizadeh, and "Metal Cutting and the Built-up Nose," W. B. Heginbotham, and S. L. Gogia, 6.30 p.m. ★ SOUTH WALES BRANCH: Demonstration Theatre, South Wales Electricity Showrooms, Kingsway, Swansea, Selected Graduates' papers, 6 p.m. ★ NORTH WESTERN A.D. CENTRE: Leyland Motors, Ltd., Leyland, Crompton-Lanchester Lecture, "Passenger Car Comfort," S. H. Grylls, 7.15 p.m. ★ COVENTRY GRADUATES' A.D. SECTION: Grosvenor Room, Hotel Leofric, Coventry, "Some Aspects of Carburation," R. C. Pack, 7.30 p.m. ★ SCOTTISH GRADUATES' SECTION: Visit to Caterpillar Tractor Company, Ltd., Tannochside, Uddingston, 7 p.m.

Wed., April 19.—EDUCATION AND TRAINING GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Undergraduate Project Work in Full-time and Sandwich Courses in Mechanical Engineering," opened by R. W. Steed, 6 p.m. ★ NORTH EASTERN A.D. CENTRE: Chemistry Lecture Theatre, The University, Leeds, "The Successors to the Steam Locomotive," L. F. R. Fell, 7.30 p.m.

Thurs., April 20.—MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting, and Repetition of the Thomas Hawksley Lecture, "Controlled Fusion Reactions," P. M. S. Blackett, to be presented by R. Latham, 6 p.m. ★ HYDRAULIC PLANT AND MACHINERY GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Co-ordinating the Needs of Hydraulic Machinery and Civil Engineering," 6 p.m. ★ EASTERN BRANCH GRADUATES' SECTION: Crown and Anchor Hotel, Ipswich, Annual meeting of Colchester/Ipswich/Norwich Graduates' Panel, 7.30 p.m. ★ NORTHERN IRELAND GRADUATES' SECTION: International Hotel, Donegall Square, South, "Some Engineering Aspects of the Food Processing Industry," J. McIlwaine, 7 p.m. ★ SOUTHERN GRADUATES' SECTION: South Dorset Technical College, Weymouth, "Technical Education for the Engineer," H. Buttolph, 7.30 p.m.

Fri., April 21.—LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "Lotus—The Design and Development," H. J. Lee, 6.30 p.m.

Sat., April 22.—MIDLAND GRADUATES' SECTION: Visit to Tangyes Ltd., Smethwick, 9.45 a.m. ★ NORTHERN IRELAND GRADUATES' SECTION: Visit to Nestlés Food Products (N.I.), Ltd., Omagh, 8 a.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., April 20.—Geological Society, Burlington House, Piccadilly, London, W.1, General Meeting, 5 p.m.

INSTITUTION OF PLANT ENGINEERS

Wed., April 19.—KENT BRANCH: King's Head Hotel, High Street, Rochester, "Plastic Bearings," J. F. L. Ludgate, 7 p.m.

Wed. to Fri., April 19 *to* 21.—Imperial Hotel, Blackpool, Fourteenth Annual Conference.

Thurs., April 20.—BLACKBURN BRANCH: Castle Hotel, Blackburn, "The Application of New Materials to Plant Engineering," J. Leyland, 7.30 p.m.

Mon., April 24.—WEST AND EAST YORKSHIRE BRANCH: Houldsworth School of Applied Science, The University, Leeds, "The Introduction of Planned Maintenance Systems," A. F. Stedman, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Tues., April 18.—LONDON GRADUATE SECTION: 10, Chesterfield Street, Mayfair, London, W.1, Lecturettes, 7.15 p.m.

Wed., April 19.—LEEDS GRADUATE SECTION: Visit to City Sewage Department, Esholt Park, Bradford, 7 p.m. ★ MIDLANDS REGION: Midland Hotel, Birmingham, "International Competition in Machine Tool Design and Production," R. Asquith, 7 p.m. ★ WOLVERHAMPTON GRADUATE SECTION: Wolverhampton and Staffs. College of Technology, Wulfruna Street, Wolverhampton, "Marketing Research and Follow Up of Sales Techniques," A. H. J. Hall, 7 p.m. ★ NORTH MIDLANDS REGION: Conference Room, Peterscourt, Peterborough, Film Evening, 7.30 p.m.

Thurs., April 20.—SOUTH EASTERN REGION: Royal Commonwealth Society, London, W.1, "High Speed Cinematography in Production," J. Hadland, 7 p.m.

IRON AND STEEL INSTITUTE

Mon. and Tues., April 17 *and* 18.—POWDER METALLURGY GROUP: Royal Commonwealth Society, Craven Street, London, W.1, Joint meeting with the Institute of Metals, Discussion on "The Appraisal of Powders for Pressing and Sintering, (i) 'Techniques for the Evaluation of Powders,' and (ii) 'The Relationship between Powders and their Pressing and Sintering Behaviour," Mon., 2.30 p.m., Tues., 10 a.m. and 2.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, April 14.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "The Thames Flows to the Lee," E. O. Abercromby, 7 p.m.

Fri., April 21.—Pepys House, 14, Rochester Row, Westminster, London S.W.1, Informal Meeting, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., April 21.—Mining Institute, Newcastle upon Tyne, "The Pametrada Hydraulic Transmission," T. W. F. Brown, P. H. Cleff and T. A. Andvig, 6.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., April 18.—MIDLAND COUNTIES BRANCH: Birmingham and Midland Institute, Paradise Street, Birmingham, "The Structural Aspects of Coventry Cathedral," P. Ahm, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Wed., April 19.—AGRICULTURAL AVIATION GROUP: Lecture Theatre, 4, Hamilton Place, London, W.1, "A Review of Current Developments in Agricultural Aviation," W. E. Ripper, 7 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Wed., April 19.—QUANTITY SURVEYORS GENERAL MEETING: 12, Great George Street, Westminster, London, S.W.1, "The Conflict Between Capital Cost and Running Costs—The Use of Cost Prediction as a Guide to Planning and Design," P. A. Stone, 6 p.m.

ROYAL SOCIETY

Thurs., April 20.—Burlington House, Piccadilly, London, W.1, "The Adhesion of Evaporated Metal Films on Glass," P. Benjamin and C. Weaver, and "Nuclear Alinement of Cobalt and the Decay of Cobalt 55," C. J. S. Chapman, J. M. Gregory, R. W. Hill and M. W. Johns, 4.30 p.m.

SCIENCE MUSEUM

To-day to Sat., April 14 *to* 22.—South Kensington, London, S.W.7, Exhibition on "Corrosion Prevention," Weekdays, 10 a.m. to 6 p.m., Sat., 2.30 p.m. to 6 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Thurs., April 20.—ROAD AND BUILDING MATERIALS GROUP: Lecture Hall, 14, Belgrave Square, London, S.W.1, Annual General Meeting, and "Some Laboratory Investigations in Connection with the Development of Cationic Emulsions," C. H. Brown, 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Wed., April 19.—DATA PROCESSING SECTION: Manson House, 26, Portland Place, London, W.1, Annual General Meeting, and "Electronic Telephone Exchanges," T. H. Flowers, 6.15 p.m.

SOUTH WALES INSTITUTE OF ENGINEERS

Thurs., April 20.—Institute Buildings, Park Place, Cardiff "Rope Attachments," E. Ivor David, 6 p.m.

TELEVISION SOCIETY

To-day, April 14.—Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2, "Transparent Phosphor Screens," D. E. N. King, 7 p.m.

Thurs. and Fri., April 20 *and* 21.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Convention on "Television and Film Techniques."

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, April 14.—39, Elmbank Crescent, Glasgow, Annual General Meeting, and "Heating and Oxidation in the Basic Open-Hearth Process," I. M. Mackenzie, D. Hadfield, T. Urie and Mrs. A. Donald, 6.45 p.m.

Advanced Engineering Courses

Nuclear Power Plant Design. NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, St. John Street, London, E.C.1. A short course intended to give a general survey of those sciences and technologies which are necessary in the design of nuclear power plant and to review the special problems associated with this design. The emphasis will generally be upon the nuclear powered electric generating station but mention is made of marine applications. The course runs from Monday to Friday, May 1 to 12. Fee twenty guineas.

Costing for Planning and Control. THE UNIVERSITY OF BIRMINGHAM, Institute for Engineering Production, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. A new course, to be held from Monday to Friday, May 8 to 19, presenting a background of cost accounting methods and procedures, and considering in some detail forms of cost analysis appropriate to some of the most frequently encountered problems of management. The course is intended particularly for engineers, operational research workers, production planners, industrial statisticians and managers. Fee sixty guineas.